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ABSTRACT

Presented are eight author contributed papers on research needs in the neuropsychological, socio-environmental, and educational aspects of learning disabilities. Issues focused on in the papers and conference include the definition of learning disabilities, the role of screening in prevention or remediation, and whether curriculum should focus on the strengths or weaknesses of individuals. Among research recommendations given for the three areas are the study of effects of social communication networks and interaction patterns on learning, developing behavioral criteria and neurological indices of hyperactivity, and developing profile type assessments to help individualize instructional programs. The following are titles and authors of included papers: "The Handicapped Learner--Recommendations for Research" (Marion Blank); "The Biological Bases of Development" (Susan Carey-Block); "Systematic Instructional Procedures--An Instructional Hierarchy" (Noris Haring); "Applied Behavior Analysis and Learning Disabilities--Curriculum Research Recommendations" (Thomas Lovitt); "Socio-cultural Correlates of Learning and Behavior Problems" (Jane Mercer); "The Mundane Extreme Environment and Its Effect on Learning" (Chester Pierce); "The Neurological Assessment of Learning Disabilities" (Rita Rudel); and "Multi-level Approach to Research in Learning" (Cynthia Deutsch et al). (DB)

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LEARNING DISABILITIES:
Issues and Recommendations for Research

Papers derived from the National
Institute of Education Conference
on Learning Disabilities, July 1974

Suzanne Gage Brainard, Editor

The opinions expressed in this publication do not necessarily reflect the position or policy of the National Institute of Education, and no official endorsement by the National Institute of Education should be inferred.

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FOREWORD

The importance of research on the problems of the Handicapped has been recognized for several years. However, the current movement toward 'equal opportunity' for all, both in education and employment, has further strengthened the significance of research in this field. More people are becoming aware of the sociological and educational implications of different handicaps. This is readily exemplified by the current trend to re-integrate the regular classrooms and children "placed" in special classes - "placed" for any number of various reasons. The inequalities of opportunity to receive a quality education are preponderant. In order to achieve quality will require further knowledge about the processes of learning and education.

One of the major goals of the National Institute of Education is to investigate ways of developing reading, writing and mathematical skills in all children through research and development on learning, teaching and measurement. One of the important sources of difficulty in developing these skills is the predominance of learning disabilities and associated behavior problems. Extensive consultation with other agencies* conducting related work revealed that more research was needed in this area. For these reasons, the Institute decided to hold the conference reported here.

The primary objectives were to: (1) explore and further clarify the determinants of learning disabilities and associated behavior problems; (2) define specific areas of research that could systematically extend our knowledge base; (3) provide a preliminary agenda for further research into the nature, causes and prevention of learning disabilities and associated behavior problems.

As a first step toward these objectives, several leading experts from a variety of relevant fields were invited to write papers providing NIE with specific recommendations for needed research. Of eight papers, two focussed on neuropsychological research, two on socio-environmental research and two on educational research. The other two papers focussed on (1) an interaction of socio-environmental research and educational research and (2) an interaction of neuropsychological research and educational research. A two-day conference was held to discuss the completed papers and to make final recommendations for further research.

The proceedings of the meeting and the papers are presented in this report.

*National Institute of Mental Health, National Institute of Neurological Diseases and Stroke, National Science Foundation, Office of Education.

INTRODUCTION

For many years children have been observed who appear normal physically, have normal intellectual potential, but have problems in learning and adjustment severe enough to prevent them from performing adequately in the classroom. Although various terms have been used to describe such children, the central and crucial features are presumed to be (1) a certain degree of vulnerability preventing normal learning, which is often assumed to be due to physiological factors such as minimal neurological impairment, or (2) some form of environmental deprivation in early development. The generic term commonly used for this group is Learning Disabled.

The learning and behavioral disabilities manifested by this group include various combinations of several psychological and physiological symptoms. Symptoms which are often mentioned include disorders in one or more of the processes of thinking, conceptualization, learning, memory, speech, language, attention, perception, emotional behavior, neuromuscular or motor coordination, reading, writing, arithmetic, discrepancies between intellectual achievement potential and achievement level, and developmental disparity in the psychological processes related to education.

In most instances, a description of a learning disabled child tends to be comparative. "Comparing him with the statistical image of the normal child provides a portrait of his "otherness'. He is 'otherwise' in relation to his environment and to the manner in which he is expected to perform."[1] He can also be portrayed in the way in which he varies from the normal profile of child development. "Physically, he grows like the normal child and his emotional needs are the same. It is in the realm of behavior and learning that he is recognized as 'other'."[2]

No accurate census exists of the number of learning disabled children nor is the percentage which they represent in the general childhood population known. Nevertheless, it is estimated that from ten to twenty percent of our school population have some type of learning disability.[3] However, all reports indicate a higher percentage of boys than girls; the reported ratio of learning disabled boys to girls ranges from 25 to 1 in some public schools to 9 to 1 in other schools.[4] The large number of special education programs which have been implemented in school systems across the U.S. to cope with this problem indicates the seriousness with which the situation is viewed by educators.

Unfortunately, our understanding of the nature of learning disabilities and behavior problems is severely limited. This is partially due to the relatively recent recognition of the magnitude of the problem - a recognition partly due to increasing discrepancies between the changing norms of the educational establishment and the school population. It has claimed the attention of researchers only in recent years, and only after educators became aware of the existence of a large group of students exhibiting some characteristics of mental retardation despite having at least average intelligence.

Currently, there are three broad interpretations of the phenomena of learning disabilities and behavior problems - the neuropsychological, the socio-environmental and the educational. According to the first, learning disabilities and behavior problems are the product of minimum and often unspecified neurological impairment. According to the second, learning disabilities and behavior problems are a product of the child's disordered environment. According to the last interpretation, learning disabilities and behavior problems are, in large part, a product of our present school system. At this time, we do not know with any certainty the validity of any of the interpretations, nor do we have any clear idea of the interaction among the three explanations in accounting for the phenomena.

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[1]Lewis, Richard S., Strauss, Alfred A., and Lehtinen, Laura E., *The Other Child*, Grune and Stratton, Inc., New York, New York, 1960.

[2]Ibid.

[3]Johnson, Doris J., and Myklebust, Helmer. R., *Learning Disabilities: Educational Principles and Practices*, Grune and Stratton, Inc., New York, New York, 1967.

[4]Cruickshank, William M., *The Brain-Impaired Child in Home, School, and Community*, Syracuse University Press, Syracuse, New York, 1967.

ISSUES

ISSUES

Several issues were raised during the course of the conference which seem of sufficient importance to discuss in addition to the papers themselves. Recurrent themes in the conference discussions were definition of a learning disability, screening, etiology, remediation, and coordination of efforts between the research and teaching communities.

Definition of Learning Disability

The literature reveals that a number of different terms are being used to refer to the population in question. Among these are terms such as brain-injured, learning disabilities, learning disorders, psychoneurological learning disorders, developmental imbalances, and minimal brain dysfunction syndrome.

One of the most difficult problems in the investigation of learning and learning disabilities has been the lack of clear definition of terminology.[5] Several diagnostic terms have been used to describe children with learning disabilities and behavior problems related to a neurological handicap. Some of these include:

- Minimal Neurological Handicap or Impairment
- Cerebral Dysrhythmia
- Chronic Brain Syndrome
- Brain Damage
- Dyslexia (by definition)

A great deal of confusion has grown out of the inappropriate use of the term "brain-injured" (and synonymous terms) to describe a group of children with mild-to-severe learning disabilities and disorganized behaviors. Stevens and Birch[6] discussed four objections to this terminology.

> "1. The term is an etiological concept and does not appropriately describe the symptom complex. This is important because the condition which prevails is viewed in terms of symptoms rather than etiology.
> "2. The term is associated with other conditions some of which have no relation to the symptom complex commonly referred to as 'brain injury'.
> "3. The term does not help in the development of a sound therapeutic approach and in practice teachers and clinicians tend to approach the problem in terms of symptom reduction.
> "4. The term is not suited for use as a descriptive one since it is essentially a generic expression, the use of which results in over-simplification."

As Birch[7] pointed out, the syndromes of dysfunction that may result from brain damage may vary with respect to etiology, extent, type of lesion, locus, duration of damage, rate at which damage has been sustained, time of life and developmental stage at which the injury has occurred. "In point of fact there is not a minimally brain-damaged child but rather many varieties of brain-damaged children."[8]

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[5]Hughes, John R. "Electroencephalography and Learning," *Progress in Learning Disabilities*, By Myklebust, Helmer R., Vol. I, Grune and Stratton, New York, New York, 1968.

[6]Stevens, Godfrey D., and Birch, J.W., "A Proposal for Clarification of the Terminology Used to Describe Brain-Injured Children:" *Exceptional Children*, 23, pp. 346-349, May, 1957.

[7]Birch, Herbert G., *Brain Damage in Children - the Biological and Social Aspects*, The Williams and Wilkins Company, New York, New York, 1964.

[8]Ibid.

After some discussion of the alternative definitions of learning disabilities, the participants decided to accept, with one exception, the Department of Health, Education and Welfare's definition as a starting point. The definition reads as follows:

> The term "children with specific learning disabilities" means those children who have a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which disorder may manifest itself in imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations. Such disorders include such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. Such term does not include children who have learning problems which are primarily the result of visual, hearing, or motor handicaps, of mental retardation, or emotional disturbance, or of environmental disadvantage.
>
> (April 13, 1970 — Public Law 91-230, 84 Stat. 177 (15))

The exception taken was to the last section of the definition, that learning disabilities could not be ". . .primarily the result. . .of environmental disadvantage. . . ."

What is the Role of Screening in Prevention or Remediation?

The position taken by Rudel and Block is that screening is necessary for either prevention or remediation. They both contend that test instruments could identify potential sources as well as existing causes of learning disabilities. In addition, they emphasize the development of relevant norms as a background against which a variety of diagnostic indices (finger tapping, naming, etc.) could be used to locate neurological and linguistic anomalies.

Deutsch, Hammer and Salzinger consider the majority of learning disabilities to be educational-system-produced. Nevertheless, they believe a preventive approach must include a constant monitoring of social, cognitive and perceptual functioning in order to achieve a good match between the child's intrinsic functioning and the demands of the curriculum.

Similarly, Pierce considers the "mundane extreme environment" (i.e., the inner city) to be the primary cause of learning disabilities, yet he does acknowledge that certain children are more vulnerable than others to its effects (e.g., birth trauma).

Blank, Lovitt and Haring share, in some respects, a perspective which does not envisage screening as a process distinct from the learning situation. Rather, they see adequate and individualized instruction as simultaneously diagnostic, preventive and remedial, depending on the existing needs of the child.

The main emphasis on screening comes from those with the strongest commitment to a biological account of learning disabilities. However, two additional positions are held. The first acknowledges that some learning disabilities can be physiologically based, and therefore are appropriate for some screening techniques, but insists that the bulk of the problem is sociologically and/or psychologically determined, for which screening devices are yet to be developed. The second position requires screening not of children but of the learning situation. In this case all children, learning disabled or otherwise, are assumed to be optimally accommodated by individualized curriculum and responsive teaching. Regardless, of origin, the deviant perceptual and sensory capacities as well as the physiological need to be assessed.

Is it necessary to determine the etiology of a learning disability in order to provide treatment?

Reliable and consistent figures indicating the number of children with learning disabilities are difficult to obtain; however, it is generally estimated at 10-15 percent of the nation's children. Within this 10-15 percent, the severity of the deficit varies on a continuum from mildly to severely disabled. As a starting point, the participants separated children with learning disabilities into two groups: those at the far end of the continuum who are severely disabled and those who fall anywhere else on the continuum. It was generally agreed that the severely disabled comprise about 2 percent of this group. According to the participants, such disabilities have a physiological basis regardless of the etiology. In addition, the

most clear-cut evidence for the presence of perceptual, neurological or other systemic disorders can be found among this 2 percent.

On the other hand, there was general agreement that some learning disabilities are not inherent in the physiology of the individual but are instead a response to inappropriate or excessive demands of the school system itself. The concept of "system produced disability," which was introduced by Deutsch, Hammer and Salzinger, was acknowledged by all participants. However, the question which arises and remains unanswered is: What proportion of learning disability cases can one ascribe, purely or even primarily, to socio-cultural causes? At this point both disagreement and confusion occur because no clear lines can be drawn between the contributing causes. The physiological and sociological factors group together to form a dense pattern of multiple causation. In some cases, the socio-cultural conflict may be strong enough to account for the development of a learning disability; in others, the psychological disturbance or the minimal physiological deficit may be pronounced enough to account for it. Moreover, it is likely that the disability can be attributed to multiple factors.

At this point one is confronted with the difficulty of pinpointing etiology, in specifying functional disturbances and then in trying to bridge the gap between etiology and remediation. Although the consensus of the conference was that determining the etiology of learning disabilities in individuals is of secondary importance to remediation, the participants did not intend to devalue basic research into the etiology of various disabilities. Instead, they emphasized the need for immediate action (which can be expected to lead ultimately to better remedies) once a learning disability appears imminent or already exists.

Should the development of curriculum be based primarily on the strengths or weaknesses of individuals?

The concept of identifying areas of strength and weakness in an individual's learning ability is not new. However, during the course of the conference various participants expressed disparate views on the use to be made of the particular strengths and weaknesses. Rudel and Block stressed the importance of neurological diagnosis in order to identify systemic weaknesses. On the other hand, Deutsch, Hammer and Salzinger recommended profile assessment, especially in the areas of perception, language skills, and social variables, in order to match children with appropriate curricula.

The question that arises is what to do once the strengths or weaknesses have been identified. If the curriculum and teaching are focussed on the areas of strength, one might indirectly foster and maintain the weaknesses. But, if the focus is on the areas of weakness, even with a remedial approach the learning process could be complicated considerably. Blank views the concept of remediation in relation to three basic questions: (1) can the deficient skill be developed? (2) can the deficiency be by-passed and the same goals be attained through other skills? (3) should the deficient area be abandoned as a goal of teaching?

Lovitt approaches the question of individual strengths and weaknesses another way — through a detailed analysis of behavior. Because he advocates dealing with one behavior at a time, his emphasis is not on potential wide-ranging deficits but on a particular learning task that cannot be performed at a certain point in time. Attention is focussed on determining precisely the conditions conducive to performing specific tasks. An advantage to this approach is that it applies equally well to normal or disabled children without entailing segregation on the basis of either potential or demonstrated ability.

Perhaps the most conspicuous disadvantage to behavior analysis is the danger of its being too context-dependent or of being reduced to meaningless units. Budoff repeatedly stressed that the essential aim of teaching is to produce self-generated learning. However, carefully calibrated teaching procedures could work against the development of such a capacity. Blank pointed out that even if one identifies precise conditions which facilitate the development of skills, the basic issue is what the child does with the acquired skills? If learning becomes context-dependent and does not generalize, a more critical form of learning disability is created. Hammer discussed further disadvantages such as overlooking indirect effects of teaching procedures, the possibilities of positive and negative transfer, and the importance of recognizing that certain things may be taught that were not intended.

Nevertheless, even those who were most concerned with the problems of closely defined teaching and curriculum consider the advantages to outweigh the disadvantages for children with learning disabilities. If the potential dangers of behavior analysis are recognized, the approach itself could be used to investigate the pitfalls of this technique. Both Haring and Lovitt agreed on the need for further research on transfer and generalization of skills and the importance of generative learning.

How can the teaching and research communities which address the problems of learning disabilities be brought together to coordinate efforts?

Although most would agree in theory that the needs of teaching and the findings of research should be coordinated, in practice, different approaches to either teaching or research often suggest different means to this end.

To illustrate: the biological approach of Rudel and Block emphasizes the development of more adequate diagnostic tests and the establishment of broader-based norms. According to this view, diagnostic needs precede curriculum design, and schools provide the relevant populations for research rather than the setting for research. Similarly, Pierce and Mercer do not see schools as critical research settings but consider them in relation to, their larger socio-cultural context. That is, variables in the entire socio-cultural setting and their effects are seen as the true target for research.

Lovitt makes the most explicit request for narrowing the gap between research and teaching by recommending the establishment of curriculum research classrooms in public schools. He considers applied behavior analysis to be the most appropriate method to combine research and teaching, and further contends that if this technique were used by both communities the gap between them would be reduced. Haring, too, recommends research on instructional techniques.

Although Blank is less explicit about the relationship between research and teaching, the focus of her research recommendations is on the needs of teachers. One of her major concerns is the need to train teachers in error analysis techniques. She implies the need for school based training of teachers, but does not give this point specific attention.

Finally, Deutsch, Hammer and Salzinger, who consider the majority of learning disabilities to be system-produced, believe that research must be conducted not only in laboratories but also in the multiple settings in which children are expected to learn (school, family, peer groups, etc.). The pressures from the teachers, school administrators, unions and the community are considered to be pervasive obstacles to change, ones which sould be studied directly — although such a focus should not preclude the laboratory study of learning itself.

The consensus of the participants was that the most direct way to assist schools in determining what changes need to be made is to work in the schools themselves. Although this is one alternative answer to the issue raised, it in no way addresses how such convergence between the teaching and research communities could be brought about.

RESEARCH RECOMMENDATIONS

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The results of the conference, as well as the breadth of research activity relating to learning disabilities, make it clear that few, if any, novel recommendations can be made for specific areas of research. Rather, it is on the individual project level that one might expect novel contributions in terms of methodology, experimental design, analysis of data and interpretation. The traditional problem with research in these basic areas is that regardless of the individual value of experimental studies, their results have not been cumulative in effect, nor have their findings been generalizable. Because of the variety of different experimental approaches, it is often difficult to compare or explain results which appear to be inconsistent. Furthermore, the research findings are too often left in the laboratories and libraries, because their application in schools, by teachers, has been far too limited.

Given that the research areas related to the problems described above remain fairly constant, our purpose here is to suggest a research strategy which might in some way obviate the fundamental shortcomings in implementation or coordination. Such an overall strategy would entail:

- Coordination of efforts between the teaching and research communities.
- Conducting more research in the school settings and surrounding environments.

A balanced, systematic strategy would integrate the variety of factors contributing to learning disabilities into a larger conceptual framework. Three broad areas to be included in the conceptual framework can be loosely designated as socio-cultural, neuropsychological and educational. Recommendations stemming from these approaches include:

Socio-cultural

- The study of social communication networks and interaction patterns among individuals, along with their effects on learning.
- The initiation of longitudinal studies of children with learning disabilities, particularly among minority populations, in order to analyze in detail the child's home and school environments and the parents' and teachers' response to these.
- The continued investigation of high risk populations for learning disability cases; that is, identifying the characteristics of the vulnerable individuals such as ethnic origin, family structure, socio-economic status, family interaction, and hospital record of gestation and delivery.

Neuropsychological

- Conducting studies of lateralization using neurological techniques to measure differential functioning between the left and right sides of the brain.
- Developing behavioral criteria and neurological indices of hyperactivity.
- Investigation of factors directing and controlling attention.
- Investigation of the development of the spontaneous occurrence of orienting, observing and search behaviors.
- Investigation of how memory changes with age, which factors improve memory and how they interact with age.

- Conducting studies of early language development, and early syntax usage, as well as studies of rapid naming, speed of object naming, and word association tests which can be used as diagnostic instruments for learning disabilities.

Educational

- Determining what cognitive strategies children use, with particular attention to the analysis of strategies necessary for the handling of sequentially based information.

- Developing profile-type assessments (particularly in the areas of perception, language skills and description of social factors) in order to determine appropriate curricula for individual children.

- Determining how a teacher can identify the phases of development in which a child functions, and the general instructional procedures appropriate to each phase.

- Identifying the specific pedagogical tactics that facilitate learning, as well as those that are most useful in helping a child overcome his learning difficulties and determining whether a common set of principles underlies these tactics.

While the research recommended covers a wide gamut, the goal is not only to stimulate interdisciplinary research but also to provide for its coordination. In a multi-faceted problem area such as learning disabilities, it would be unwise to neglect whole areas of research in favor of a narrower focus on either one discipline or purely experimental research . With both the causative and remedial factors pertinent to learning disabilities still to be isolated, one cannot predict from which discipline or area a breakthrough is most likely to come.

In other words, the strategy proposed in one that does not call for only the further refinement of the neuropsychological, socio-environmental, and educational perspectives, but a synthesis of these three perspectives. For example, research to resolve some of the anomalies resulting from the existence of the three perspectives is sorely needed. An adequate research strategy should be inclusive rather than exclusive, but systematically so, ensuring balance and coordination of all its components.

ABSTRACTS OF PAPERS

THE HANDICAPPED LEARNER: RECOMMENDATIONS FOR RESEARCH

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Overview

Two major areas of research for the handicapped child are the focus of this paper. One is the development of techniques for understanding the cognitive processes responsible for the difficulties of the child with learning impairments. The hypothesis is advanced here that a central and little studied area is the children's difficulty in the handling of complex, sequenced information (e.g., a reading passage) where the focus rapidly shifts so that a range of 10 to 15 major different cognitive demands might be made in a period of a minute or two. Relatively few research techniques are available for studying the sequential organization of thought. Therefore, basic research in this area is essential.

The second area for suggested research is that of program development and teacher effectiveness. Even if the factors responsible for the children's difficulties were understood, the problem remains of determining whether areas in which they are deficient can be, a) developed directly, b) achieved through compensatory techniques that by-pass the difficulty, or c) whether the area should be abandoned as a goal of teaching.

In addition, information is needed on the precise role that teachers play in children's learning. Precise measures must be developed to determine the effectiveness with which they help, and fail to help, the child to master the material with which he experiences difficulty.

Research Recommendations

The study of cognitive processes contributing to the difficulties of learning disabled children should include:

- Determination of what strategies children use in coping with academically related cognitive demands.
- Determination of which aids or cues are most helpful in overcoming the difficulties.
- Analysis of the demands of school-based material after the fourth grade and
- Determination of the extent to which a well-functioning child spontaneously places new information in an implicit framework and the extent to which this skill is present or absent in poorly functioning children.

THE BIOLOGICAL BASES OF COGNITIVE DEVELOPMENT

Susan Carey-Block
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Overview

It is proposed in this paper that the biological bases of learning disabilities be studied in the context of the biological bases of normal development. Rather than look for abstract, general descriptions which apply to all intellectual functioning, specific abilities should be chosen and analyzed in depth. The contention is that biological evidence for many different cognitive and perceptual mechanisms with different developmental courses appears to outweigh evidence for overall stages.

To illustrate, two cases of specific development are presented: one being an ability dependent on left hemispheric functions (speech perception at the phonemic level) and the other dependent on right hemispheric functions (face perception).

Three models for the biological bases of learning disabilities are discussed: 1) general maturational lag 2) slow differentiation of or slow development of connections between cortical areas of specialization, and 3) highly specific syndromes.

Research Recommendations

Research into the biology of normal development is recommended. This would include:

- The study of the normal course of lateralization of function, of commitment of cortical areas, of critical periods for various feature detector systems and of completion of the functional connections among various areas of the brain.
- The use of clinical adult syndromes as a basis for understanding the developmental of abilities basic to learning problems.
- Establishing developmental norms in order that learning disabilities can be tested and diagnosed in terms of functional systems.

SYSTEMATIC INSTRUCTIONAL PROCEDURES: AN INSTRUCTIONAL HIERARCHY

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Overview

As a result of the need for more precisely arranged instructional events, the development of a hierarchy of instructional procedures is proposed. This hierarchy would yield guidelines for instruction and performance evaluation. In addition, it would enable teachers to promote pupils' continued growth through improved individualized instruction.

The four classes of instructional procedures proposed are: demonstration and/or modelling; drill; combined drill and practice; and application. The problem is to determine the functional relationship between these procedures and the various phases of skill development - acquisition, mastery, maintenance, transfer and generalization.

Research Recommendations

It is suggested that research must go beyond the present concern with broad hierarchies and begin to investigate the discrete task levels within an overall hierarchy of skill development.

The development of steps within such a hierarchy requires four areas of research:

- To define and differentiate the various phases of skill development.
- To determine general instructional strategies which are effective during each phase of learning.
- To determine the relationship between specific instructional tactics and certain types of skill development.
- To investigate systematically any learning that involves a number of discrete skill levels.

APPLIED BEHAVIOR ANALYSIS AND LEARNING DISABILITIES: CURRICULUM RESEARCH RECOMMENDATIONS

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Experimental Educational Unit
University of Washington

Overview

The paper describes the principles of applied behavior analysis as they relate to the study and remediation of learning disabilities. The methodology, which is directed at a fine-grained analysis of individual behavior, requires direct measurement, daily measurement, replicable teaching procedures, individual analysis and experimental control.

Since learning and what is learned are simultaneous aspects of the learning process, detailed analysis is also applied to the curriculum areas (six in this case) in order to identify the components of the behavior which demonstrate suoject mastery. Optimal sequencing of these skills and techniques to determine how they can best be developed (whether specific to individuals or generalizable) must also be determined. It is contended that the learning process does not end with mastery of a defined set of behaviors, for the retention and transfer of skills, whether as responses or across stimulus situations, are crucial to learning ability.

Research Recommendations

Six curriculum areas (reading, spelling, composition, penmanship, arithmetic and pupil-management) are considered in need of research to specify the elements which comprise them and to establish the sequencing of these elements. Then the techniques which are best suited to developing these requisite skills, or elements, must be established. Mastery, retention and generalization, along with the conditions that influence all three processes, should be researched.

Furthermore, if research findings are to be applied in the classroom, logistics research into classroom management must be encouraged.

This would require:

- Establishing a confederation of university research units, with each unit using similar methodology but focussing on a specific curriculum area.
- Establishment of research units in public schools.

SOCIO-CULTURAL CORRELATES OF LEARNING

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Overview

In this paper, the characteristics and assumptions of three conceptual models are delineated and recommendations are made for their use in studying learning disabilities and behavior problems. The three models are the Pathological, Statistical and Social System.

The Pathological Model is appropriate when there is reason to hypothesize that certain socio-cultural factors are producing measurable changes in the biological organism of the child; these changes are producing specific behavioral manifestations; and these behavioral manifestations are regarded as disabilities or problems in most socio-cultural groups.

The Statistical Model is appropriate when it has been established that the investigator is dealing with a single population, statistically and socio-culturally; that the distribution of behavioral manifestations in the population is normal; and that there is a value consensus in the population that the behavioral manifestations under study are of substantive significance and not an artifact generated by the model.

The Social System Model is appropriate when there is reason to hypothesize that behavioral manifestations are both social system specific and status specific, primarily behavioral definitions of role performance generated within a social group; when "normal" structure, the expectations of which are determinable by studying the direction and degree of positive and negative sanctions operating within the system; and when "problem" behaviors do not have any clearcut biological basis.

Research Recommendations

Two recommendations for a research agenda of projects dealing with the socio-cultural correlates of behavior are made:

- The use of a variety of conceptual models or perspectives integrated into a balanced, systematic research effort.
- Explicit recognition by each investigator of the particular conceptual model or perspective he selects and its implications, which will, in turn, determine how "learning disabilities and behavior problems" will be defined and operationalized.

THE MUNDANE EXTREME ENVIRONMENT AND ITS EFFECT ON LEARNING

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Overview

This paper starts with a consideration of the special and diverse problems that baffle and confound the consideration of "learning disabilities and behavior problems" in the minority poor. As a model for the generation of researchable ideas it is suggested that life adjustment in an inner city should be compared to life adjustment in an extreme exotic environment. The inner city can be classified as an extreme mundane environment. It is hypothesized that it is much more difficult to live under mundane than exotic duress. Since so much useful data have been accumulated about adjustment and learning in the exotic situation it is thought that this informatin could be useful in making novel and impactful research in the inner city.

An analysis of the attributes of an extreme environment are presented. These attributes include forced socializing, depression, spatial isolation, time elasticity, biological dysrythmia, sociological dysrythmia, increased free time, noise/silence extremes, loneliness, fears of abandonment, anxiety, panic, information fractionalization, boredom and inability to escape.

Learning and behavior problems are considered to develop in relation to these attributes. The attributes in various combinations cause some population sub-segments in the inner city to be especially vulnerable to a plethora of grievous symptoms of augmented dependency, decreased self-confidence and exaggerated deference. Such symptoms serve survival although in a less than effective manner.

Research Recommendations

Recommendations for basic and applied research are made on the basis of the submitted theory. In general the recommendations are for a commitment of "outside world" interest (similar to that given to astronauts or polar explorers). Specific proposals emphasize the need for careful descriptions of Black populations in the move toward constructing quantitative research.

NEUROLOGICAL ASSESSMENT OF LEARNING DISABILITIES

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Overview

Research findings are presented to indicate that early brain damage spares sensory and basic language functions, with the effects of such impairment being most apparent at complex levels of functioning. Furthermore, impairments in complex functioning are found to be comparable to those which result from brain damage in adults. In the case of early damage, regardless of the etiology — brain trauma, genetic differences, or environmental deprivation — the disability appears to lead to physiological alterations which in turn result in problems with learning.

Sysfunctions in three areas — attention, lateralization of function, and language — are considered to be both widespread and of special significance in relation to learning disabilities.

Research Recommendations

Research on diagnostic instruments is strongly recommended. The focus of such research is on the development of neurological and physiological tests to locate the area of dysfunction. Specific areas for research include:

- Development of behavioral criteria for hyperactivity and attentional deficits at home and at school, through the development of neurological indices.
- Laterilization studies based on neurological indices to measure speed of performance on left and right sides of the brain and the difference between them.
- Language studies of early language development, early syntax usage, and rote memory tests, as well as studies of rapid naming, speed of object naming, word association tests to test for fluency and possible early dysphasia.

MULTI-LEVEL APPROACH TO RESEARCH IN LEARNING

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Overview

This paper has been based on the premise that learning disabilities, as they have been traditionally defined, are in large measure a product of our present school system. For an enormous number of children whose backgrounds are discontinuous with the cultural norms of the school, the system has actually produced intellectual problems where none need exist. Only for children who have measurable sensory and perceptual difficulties has remediation been successful. But for the large majority of children labeled learning disabled, the typical techniques of remediation have failed because what is needed instead are flexible curricula and teaching procedures adaptable to the differing needs of different children.

Research Recommendations

Priorities for research resulting from such a conceptualization can be set forth on several levels, ranging from social analyses of the schools and the children they serve to assessment techniques for individual children. Within this broad range, attention should be focussed on a number of research areas:

- Studies of existing social networks and how such information can be utilized in improving learning.

- Studies in perception and learning focussed on the questions of modality influences, the role of feedback in learning, the development of orienting, observing, and search behavior, factors directing or controlling attention, and the development of memory and investigation of factors which enhance it.

- Studies in language focussed on its use in the organization and conceptualization of information and for communication; and studies geared toward the development of individual assessment procedures.

THE HANDICAPPED LEARNER: RECOMMENDATIONS FOR RESEARCH

Marion Blank

The term "handicapped learner" is a deceptively simple label that subsumes a number of complex issues. These include a) the different entities represented by this term, b) the different processes responsible for the learning difficulties and c) the different treatment procedures that must be adopted if effective learning is to occur. Given a problem of this breadth, it is inevitable that any single investigator's view of the issues is going to be influenced, and ultimately restricted, by the particular focus he or she has had on the problem. In my own case, my major experience has been with those children from socio-economically "disadvantaged" backgrounds who function poorly in the academic setting. This is by no means a small group; in fact, they probably form the majority of handicapped learners in this, and in most, technologically advanced countries. Nevertheless, their difficulties are in many ways different from those of other handicapped learners and the comments that follow should be interpreted with this limitation in mind. One further proviso is in order with regard to the comments that follow. In an effort to focus on which I believe to be the key problems, I have oversimplified some of the questions and issues. In all cases, however, I have endeavored to retain the essential findings that have been obtained in particular areas.

As is the case with many forms of disability, the identification of the poorly functioning disadvantaged child is not difficult. Any number of socio-familial and psychometric measures can be and are being used, to predict, with a relatively high degree of accuracy, the children who are likely to encounter difficulty in school. These measures include such variables as number of children in the family (the larger the family, the greater probability of poor learning in the children), sex (boys exhibit considerably more difficulty than girls with the ratio being about 4 to 1), educational level of the parents (the fewer grades completed by the parent, the poorer the performance), IQ performance, (the lower the child's IQ, particularly in the range under the mean for his economic group, the greater the likelihood of failure), first grade classroom behavior (the greater the behavioral problems shown in first grade, the greater the likelihood of poor performance throughout the school years), auditory discrimination (the poorer the ability to judge similarities and differences between sounds, the poorer the school performance), finger tapping (the slower the rate of tapping one's index finger for a one minute period, the poorer the school achievement), and so on almost ad infinitum. Thus, it is not difficult to identify the children about whom we are concerned. In many cases, through the use of socio-familial data, the prediction can be made at, or even before, birth; through the use of psychodiagnostic instruments, the identification can be made with approximately 80 to 90% accuracy by kindergarten age.

The key problem with this group of children, is not in diagnosis; rather it is in understanding the processes responsible for their disability. It is in this area that I believe much of the educational research effort should be concentrated. In calling for an identification of the processes responsible for learning difficulties, I am not referring to further correlational studies which will again show that poor academic achievement in these children is associated with poor performance on a particular test. We already know that almost any developmentally sensitive cognitive task will show a relationship to learning difficulties. That is, on almost all the tests used the poorly functioning child will show a delay, or what has been termed a developmental lag, on the skills in question.*

The presence of a developmental lag argues not only against the development of additional tests that will correlate with school performance; it also has implications which argue against the usefulness of

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For example, on tests such as those of finger tapping, auditory discrimination, use of concepts, and vocabulary, the handicapped learner shows a one to three year lag (depending upon the nature of the test and the age of testing). Thus, if a well functioning child achieves certain auditory discriminations at 5 years, the handicapped learner will learn to make these discriminations at 7 years. Furthermore, this developmental lag is present in the lower socio-economic groups of all technological countries (where the factors of race and class are not confounded as they are in the United States).

*Prepared for the National Institute of Education-June 1974.

looking toward developmental theories (e.g., Piagetian theory) to aid our understanding of the handicapped learner. Such theories are of limited value because they have been formulated to explain general developmental patterns; that is, patterns that are characteristic of all children. As a result, they focus on skills and concepts acquired by all. For example, using the terms of a Piagetian frame of reference, all children master the achievements of the preconceptual, intuitive, and concrete-operations stages and concrete-operations stages and they acquire them in precisely that sequence.

The emphasis on total uniformity has the value of characterizing all the laws applicable to human development; at the same time, however, it leaves little room to explain group or individual differences in development. In other words, it fails to account for the obvious and tremendous variation in performance and skill that children display. For example, the only possible source of variation in the Piagetian scheme is in the rate of development-that is, while the cognitive achievements of a stage are identical across children, some children achieve the stage earlier than others (e.g., a child may start the preconceptual period at two years, and another child at three years).

This difference in the rate of achievement has, as indicated above, acknowledged practical value since it is probably the most significant predictor of school success. Despite its practical importance, Piaget views the rate factor as being insignificant relative to the constancy of the sequence. He explicitly emphasizes his lack of concern with the age at which any achievement emerges and concentrates instead in describing the invariant sequence of developmental stages. This approach is of obvious value in helping us dispense with a wide range of superficial differences. For example, it is not especially significant whether a child reaches for a hidden object at eight as opposed to ten months, or begins to speak at eighteen months rather than two years. When carried to its extreme, however, this outlook would mean that the pace of development has no qualitative impact on the eventual level of adaptation.

If this were true, there need be little concern about poorly functioning children. Even though their rate might be somewhat slower, we could confidently expect that adequate levels of achievement would eventually occur. The children would simply take an extra year or two to reach the same stage as those who are more advanced. But we know that this is not true. The failures in achievement tenaciously maintain themselves throughout the years of school. Thus, the end product of a slow rate of development is an enduring restriction on cognitive attainment; poorly functioning children's rate of development is slower than that of well-functioning children from the early years and the difference is never overcome. As a result of focusing exclusively on skills that are uniform for all, developmental theory thus cannot grapple with one of the most central problems of poorly functioning children-namely, the limitations that mark their ultimate level of achievement. It is for this reason that I believe a central task of educational research is the development of models that will account significant group differences in cognitive functioning.

At this point, I would like to outline what my research has led me to believe might be some of the factors responsible for the children's poor performance. My interpretation starts with a fact raised earlier; namely, that the handicapped learner fails a vast number of tasks. Associated with this failure is an interesting phenomenon; that is, although the children perform poorly on a wide range of tests, it is remarkably easy to raise their scores. In addition, the elevation in performance is frequently achieved through what seems to be relatively trivial procedures. For example,

a. One task on which the children do poorly is a cross-modality reaction time task in which they have to press a telegraph key as soon as they perceive either a light or a sound. The reaction time of the handicapped learner (from kindergarten through third grade) on this task is much slower than that of the well-functioning child. But the "deficit" can be overcome by simply giving the handicapped child a number of training trials (e.g., about 50-60 trials) before administering the task.

b. the slow learner functions poorly on vocabulary items. (i.e., defining words he hears). In a few class sessions, however, he can be taught the words so that the difficulty (on that subtest) "disappears."

c. the handicapped learner has difficulty in visual search tasks such as locating an embedded figure in a complex field. With change in the instructions, or with practice, or with seemingly minor simplifications in the visual field, his performance improves markedly.

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The precise techniques needed to achieve the improved performance will vary according to the nature of the task and the age of the children. But the point is that the improvement is relatively easy to achieve. Of course, in most, if not all cases, the improvement is in the test score alone; the child's academic performance is not altered.* As a result, these training procedures frequently ruin the test as a diagnostic tool for differentiating and predicting between well-functioning and poorly-functioning children. Implicit in the rapid improvement, however, is a little discussed, but highly significant fact—namely, that *the skills being tested are not beyond the handicapped child's functioning; rather that he cannot readily identify and mobilize the skills relevant to a particular set of materials when the materials are first presented.* In other words, what the handicapped child lacks relative to the well-functioning child is not particular skills so much as a generalized set for analyzing novel tasks in a way that permits him to adapt to their demands.

The generalized set to which I am referring is exemplified in the following anecdote. A well-functioning five year old had just taken a reading readiness test. Upon returning to her classroom, she reported to her teacher "I had to work with letters. Like I had to put a big A with a little a, a big B with a little b". She then paused and independently corrected herself, "It wasn't exactly like that. That would have been too easy. They mixed the letters all up. First there was a G and then a D and then an M." The child's remarks showed that she was familiar with the content being tested. But her comment was indicative of far more than familiarity. She was saying, in effect, that she had recognized that there was a design in the seemingly independent items. This recognition was not solely a function of the information available in the environment at that moment. Rather, it was also a function of the child's internal mental set; a set that led her to analyze the information offered in the specific content of the test and thereby to discern the unstated, but nevertheless definite structure that lay behind the design of the test.

This interpretation stands in contrast to the framework that generally has been used by special education in understanding the difficulties of the handicapped learner. In this latter framework, there is generally greater acceptance of the idea that the test validly measures the behavior which it is purportedly designed to measure. Given the psycho-educational framework in which the tests were constructed, the areas measured are usually placed within such rubrics as memory, vision, audition, language, and spatial concepts. Accordingly, when a child performs poorly on one of these tests, the conclusion is generally reached that he lacks the skills which the test is designed to measure (e.g., he is said to have problems of visual discrimination, verbal labeling, etc.)

The alteration in performance achieved through relatively minor changes in test procedure casts doubts on whether interpretations of specific skill deficiency is valid. If the skill in question were truly deficient in an individual, it seems unlikely that it would appear in relatively intact form simply through minor procedural changes such as varying the instructions, being given additional practice trials or suggesting to the children that they follow a particular strategy on the task. Instead, it is hereby suggested that the reason for the handicapped learner's poor performance is that he has difficulty in discerning and/or imposing a pattern (s) on the specific material with which he is confronted. As a result, he is at a severe disadvantage in knowing how to meet its demands.

If this analysis is valid, it suggests that a major research effort should be devoted to understanding "what goes on in the mind" of the handicapped child when he confronts an academically demanding type of task (and conversely, what goes on in the mind of the well-functioning child under the same conditions). I do not mean to suggest a return to introspectionism. If nothing else, it is unlikely that the children could verbalize their reactions and ideas in a test situation. Instead, I am suggesting that the

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This finding has important implications for teaching programs geared to rehearsing the child in the skills in which he is deficient. He may learn these isolated skills, but the transfer value to general academic achievement is negligible.

response patterns of the children be carefully analyzed to determine what methods of attack they are using on any task.* We know from much of the recent work on cognitive and linguistic development, that the behavior patterns of the normal child, no matter how immature they may be, are not random. Analagously, I believe that the patterns of response that the handicapped learner uses in test situations are not random. Instead I believe that they are based upon the child's use of different strategies that in many ways are less efficient and less appropriate. The analysis of error patterns or error sets that needs to be done is not that of analyzing the particular items failed (e.g., finding that the child fails tasks demanding concepts of laterality). Although such an analysis need not be totally excluded, it is not likely to prove most useful. It continues the tradition of viewing the child's difficulty as the absence of specific information or ideas, rather than as the more generalized difficulty of superimposing a meaningful organization on complex material. Therefore, instead of content or item analysis, I would prefer to see the error analysis aim at:

1. defining the type of organization that the child uses on tasks at which he succeeds and at tasks in which he fails (e.g., is he drawn to salient perceptual features thereby overlooking subtle, but essential cues; does he fail to recognize the relationships among similar items, does he fail to anticipate the demands of the test, etc.)

2. Identifying the cues or aids that are most helpful to the child and, in particular, trying to discern whether these aids share a common set of principles. As noted above, the children can be helped, through the use of various aids, to perform much more effectively on the various skills that are tested. If more effective curricula are to be designed, it is important to determine

a. what aids are most helpful to the child (e.g., practice, mnemonic devices, training in impulsivity control, etc.)

b. whether certain aids are preferable in certain kinds of tasks (e.g., imagery on visual spatial tasks) and

c. whether certain principles can be extracted as underlying the various aids (e.g., is verbal mediation a common denominator to many of the effective aids?)

There is an additional area of behavior that is integrally related to this analysis, although it is extremely difficult to actually carry out research in this sphere. The area to which I am referring is the *sequential organization of thought and language* (i.e., the way thoughts link together and follow one another in the development of an idea or concept). Generally most tests are designed so that "like items" are clustered together. (This format is in keeping with the goal of obtaining separate assessments of the child's performance in each individual sphere). For example, the Wepman Test presents the child with 40 consecutive pairs of similar versus identical words and the child must judge if the words are the same or different; the Bender-Gestalt presents 10 visual-spatial patterns which the child must reproduce; the digit span test will present groups of digits to be recalled. When these skills are called upon in reality-based situations, however, they are not clustered in this way. For example, if one has to draw a spatial pattern such as a map, this production will be carried out in the context of *discussing directions to a place, finding out whether the person requesting the information knows anything about the area* (for this will determine what information is put on the map), *there will be citing of cues one should look for on the way*, (e.g., the gas station on the left), etc. In other words, the natural, spontaneous use of cognitive and linguistic skills is one that involves a sequential, constantly changing set of tasks. In such a situation, information is meaningful only if the participants in the exchange constantly shift their focus so as to extract the essential parts of each succeeding bit of information.

Some of Harlow's work on Error Set (developed with non-human primates) might serve as a prototype for this research. For example, when a monkey is required to learn a size discrimination (e.g., a big vs. a small circle), he may fail for a number of trials until he finally achieves the "desired" solution. His behavior during the failure period, however, is not random; rather, it has been found that he is using alternative, albeit nonproductive, strategies in response to the situation (e.g., he may always respond to the left side regardless of which stimulus has been placed in that position). Any error type analysis would have to be considerably broadened beyond the work conducted by Harlow since the range of tasks which the child must tackle is much greater than that presented to the laboratory animal. Nevertheless, I believe that this type of analysis could prove most useful in understanding the difficulties of the handicapped learner.

Nowhere is the sequential and changing set of processes clearer than in reading. For example, take the following passage drawn from a 7th grade social studies text:

> "Americans debated the future of the Philippines. Should the islands become independent? Or should they belong to the United States? If independent, could the Philippines remain free? Germany, Japan and England were extending their power. One of them might take over the islands. But could the United States force its rule on a people that wanted to be free? After all, Americans believed that people had the right to govern themselves."

To anyone comfortable with a written verbal system, the connections between the sentences seem obvious and natural. In fact, though, each sentence covers quite a different theme and the connections between sentences are almost always implicit. For example, the first sentence focuses on controversy concerned with a proposed course of action for a particular country. The "proposed course of action" however is never stated explicitly; it is only implied in the term "The future." The next two sentences specify *two of the possible actions*—independence or federation. Nowhere is it stated that these are the referents for "the future." In other words, "future" here does not refer to time alone, but to a condition that might be brought about in the coming time. The fourth sentence then goes on to consider the *implications* of each possible ("if. . . then") and the fifth and sixth sentences suddenly bring in three previously unnamed powers who might threaten the territory in question. It is left for the reader to conclude that such a takeover is one of the dangers of "independence"—nowhere is this connection made for the reader.

For the literate person, this analysis may seem unnecessarily detailed. But I believe that the seemingly endless need for connections represent precisely the source of difficulty for the poorly functioning child. Even if he can read each word, he cannot put the material together to make a meaningful and comprehensive unit. In addition, I feel that the biggest hardship he faces is his difficulty in rapidly shifting his focus so as to extract and relate the essential ideas of each sentence—when each sentence covers totally different concepts and processes (e.g., one sentence may be a statement of fact, another may be a prediction, another may be analysis of a conditional situation, ect.) Thus, in a sense, actual reading material is even harder than the traditional tests which the children take. In the traditional tests, the material is grouped so that gradually the essential commonalities across items emerge and the children can begin to apply the most effective set for handling the information. That is why practice is probably so useful for the poorly functioning child and why it results in a marked elevation in performance (i.e., the child finally adopts a useful strategy and continues to apply it because the same demands are maintained throughout the test). In actual reading, however, there is no such concentration of common items. If the material is to be comprehended, the reading of each sentence must be accompanied by a rapid shifting of ideas. It is almost as if the child were taking endless number of different test with only one item from each test. Little wonder then that the poorly functioning child who does poorly on tests which have clustered (and thus helpfully grouped) items, does so badly on written material where there is no such concentration to help focus his effort.*

Lashley, in his classic paper on "The Problem of Serial Order in Behavior", spoke about this problem—that is, the integration and coordination of sequenced behavior, in particular, he stressed "the logical and orderly arrangement of thought and action" as being central to understanding higher level human functioning. He went on to say that "language presents in a most striking form the integrative functions that are characteristic of the cerebral cortex and that reach their highest development in human thought processes." This latter statement raises some interesting problems which I believe are worthy of much research. Specifically, it seems vital to determine the similarities and differences between oral and written language and then to assess the role these factors play in the scholastic difficulties of the handicapped learner. My thoughts in this area tend to go as follows:

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*These comments apply mainly to reading above the fourth grade level, where the goal is "reading to learn" (i.e., using written material to extract information). Below this level, the nature of the material is much simpler and the main difficulty in "learning to read". For the latter goal, the main task is to "crack the oral to written code". Although this task is not easy, (and it does pose problems for the poorly functioning child), it is not nearly as difficult as the post fourth grade use of written language as a means of gaining information.

Clearly oral and written language* are not identical. The differences are many, to cite only a few of them—oral language (aside from lectures) is usually conducted in a setting of two or more persons where there is constant back and forth among the participants; oral language is greatly aided by contextual cues, facial and bodily expressions, sharing of implicit values and ideas by the participants, etc. For the most part handicapped learners do not experience the severity of difficulty in oral language acquisition as they do in written language acquisition. Nevertheless, in the years of early language acquisition they do not generally show as good performance on oral language measures as does the well-functioning child. Frequently, the measures on which they perform poorly are termed "metalinguistic skills" to distinguish them from linguistic skills alone. That is, the children use language reasonably well in many situations, but they have difficulty in analyzing language—in treating language as a thing that can be subjected to cognitive analysis. Tasks in this area include those such as rhyming ("give me five words that sound like bat, cat, etc."), word analysis ("what is the beginning sound in the word MAN; why do you think *skyscraper* was given that name?" etc.) and vocabulary (i.e., defining words that one knows and uses). On a correlational basis, we know that poor performance on metalinguistic skills relates to poor reading achievement in school. It would seem vital to determine to what extent these two areas of skills share common demands and to what degree one is dependent upon the other. Even more in line with the comments above, it would seem essential to determine the shared sequential properties of each. Oral speech, like written speech, is based on an ongoing, evolving elaboration of ideas. Each bit in the sequence determines the appropriateness of the information that will follow. To give an extreme example—the statement "The car is blue" is a perfectly meaningful and reasonable idea. But it becomes ludicrous if it is given as an answer to the question "What is the weather like today?" In other words, like dialogue, written language seems governed by a set of rules which the well-functioning person implicitly recognizes and uses so as

a. to anticipate what information is likely to follow after a particular statement or question,

b. automatically supply information that connects two ideas (as in "the future" and "independence" in the paragraph above) and

c. to keep in mind ideas offered in the first sentences in order to make sense out of the ideas that will follow. Like so much of language, our knowledge in this sphere is intuitive; we easily do about performing these feats without feeling the need to analyze the process. If we are to understand and help the handicapped learner, however, I believe it essential to define the processes that underlie the logical, sequential ordering of verbal information (e.g., when are *memory* items brought in, when does one ask for a *rationale* for a judgement, when does one *describe* a situation, what is the most likely formulation to follow a *descriptive statement).* In addition, these sequences are likely to vary greatly with content (e.g., discussion during and about daily routines, such as washing dishes, will almost certainly evolve along a different path from discussion of an abstract issue such as designing more effective voting procedures).

Once some methods have been arrived at to define sequencing processes in oral and written language, it would be necessary to test the handicapped learner in these areas. My own research on limited and laboratory-created tasks leads me to believe that the handling of sequenced information is a prime, if not the prime, difficulty of these children. In fact, I believe that their poor performance on the isolated tests discussed earlier (e.g., visual spatial reproductions, auditory discrimination, verbal labeling) is at least, in part, an artifact of their sequencing difficulties. That is, when the well-functioning child is given a novel test, he immediately places it within a logical, orderly framework. As a result he recognizes what processes are likely to be relevant, what information can be disregarded, how the material is likely to be sequenced, etc. In a sense, he is almost reading the mind of the developer of the test and is having a dialogue with him, even though he (the test developer) is not "present" in the testing setting. By contrast, the handicapped learner engages in little of this process. As stated earlier, if the examiner restructures the task so as to help him to recognize or practice its essential demands, his performance improves greatly. But, in the absence of this aid, he takes each item by itself. As a

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*Written language here includes both reading and writing.

result, he cannot anticipate what is focal from what is not; he is slow to build up a learning set to aid transfer since he is not geared to see the commonalities across items, etc.

The material until now has focused on understanding the nature of the difficulty experienced by the handicapped learner. I would now like to turn to an area which is integrally related to this issue and which demands a major research effort. This is the area of remediation or treatment. The first major issue in almost any educational treatment is that of determining *whether the difficulty can be by-passed* (i.e., should certain skills not be taught and/or should they be taught by other means), or *whether the child must be helped to develop the skills in which he is deficient.* I do not believe that the answer to this problem will be an unqualified yes-or-no. In general, I think the answer will depend upon the nature of the task, the deficits the children are found to possess, and the age of the child. For example, many years ago Bereiter pointed out that early reading is taught in a way that demands that the child apply higher level cognitive processes in order to understand the material presented. He went on to point out, however, that early reading materials need not be presented this way. If they are carefully programmed, they can be organized in small steps so as not to present the child with situations where he has to "figure out" what is meant. As a result, he can master the tasks without having to have recourse to higher level cognitive processing. But later reading skills (e.g., sustained reading and comprehension of relatively long passages) are almost certainly governed by different factors and demand different skills—skills which cannot be developed by compensatory techniques that by-pass complex cognitive strategies.

In general, there has been remarkably little research on the demands of post-fourth grade reading level, even though this period represents a major obstacle for poorly functioning children. The importance of this period becomes even greater when one considers that it is only after fourth grade that one begins to gain real competence in reading as a means of gaining information about the world. One cannot determine at this point which areas of academic performance in reading and mathematics can be attained through simplified compensatory techniques and which can only be attained through more complex cognitive skills. Research in this area is vitally needed, although extremely difficult to undertake.*

In exploring and evaluating alternative teaching methods, it seems useful to do research on a commonly cited (but rarely demonstrated) idea—namely, the desirability of developing teaching methods that are not as heavily dependent upon verbal material as are our current techniques. It is frequently pointed out that poorly-functioning children have great difficulty in dealing with long, complex, sequenced verbal material. Accordingly, the idea has been raised that perhaps we can teach through other means that depend less upon the verbal realm. In fact, it is argued that we have placed excessive reliance upon verbal material—even when the material is not well suited to it, (e.g., as an extreme example, learning to drive a car is easier and faster through actually driving it than through hearing lectures about it). The idea of non-verbal techniques to supplement and/or replace verbal techniques is an intriguing one. Unfortunately, I have never seen the idea actually worked out in any comprehensive way that demonstrates its feasibility for academic-type material. The idea has particular difficulties for learning handicapped children, for I believe they are unlikely to spontaneously apply their own inner language skills to aid them in many learning situations. For example, a Montessori program is one type

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*One of the hazards in such research is the understandable tendency of experimenters to narrowly define the variables under study. However, broad issues of general learning and transfer are involved in any study of school performance. One cannot gain a clear and meaningful picture of the total situation unless the usual limited number of variables are expanded at least to include both negative as well as positive effects of any training method. I will try to highlight this point through an illustration derived from experimental work with children. In problem solving tasks, in the laboratory, it is common to present children with a visual discrimination task involving two or more stimuli. If only one pair of stimuli are used in the first task, (e.g., a big vs. a little circle) children as young as 3 years learn the problem easily. Their transfer to subsequent problems, however, is relatively limited (i.e., if the stimuli are similar to the training pair, they do well; if the new stimuli are markedly different from the training pair, they do poorly). By contrast, if two different pairs of stimuli are used in the training task, the training problem is greatly complicated and the children take a much longer time to solve the problem. If the analysis of the results is limited to the training problem, then, the two pair situation seems like a poorer way of presenting information to children. If the transfer situation is considered, however, the analysis looks quite different for training on the more complex problem leads children to show much better transfer to a wider range of subsequent tasks. That is, the initial learning is slower, but it allows more effective and broader later learning. I did not intend, through this example, to imply that more difficult training procedures are more desirable. Rather, I used this illustration to point up the need to set up studies in a way that permit one to assess the advantages and disadvantages of any training system. This is in contrast to the usual practice of trying only to show the advantages of a particular system.

of program based upon the idea of non-verbal teaching and learning. Well-functioning children frequently do well in this setting. I believe that this occurs because they themselves supply the (verbal) interpretation that makes the events they are experiencing meaningful. By contrast, poorly-functioning children learn to carry out many of the tasks, but they do not seem to try to understand nor interpret the significance of the tasks as they deal with them. As a result, the experience does little to help them overcome their difficulties. Thus, I am skeptical about the success of a "non-verbal approach" to teaching handicapped learners. Nevertheless, I do believe that it represents such a potentially important concept that any reasonable research efforts in this area should be encouraged.

There is one further area that I would like to discuss relative to the idea of educational efforts to help handicapped learners—that is the area of teacher behavior. It is evident that teachers play a central role in the way and in the rate with which material is offered to the child and, therefore, they are a key factor in the success of any program that will be instituted. It is unclear, however, as to which of his (her) behaviors are effective, which are benign, and which are counter-productive. There are an increasing number of rating systems available by which to assess teacher behavior. Many of them, however, have limitations, particularly with reference to the handicapped learner. For example, few give any consideration to the teachers' handling of wrong responses-that is, how effectively he or she helps the children over difficulties they encounter with the material.

The reasons for neglecting the wrong response probably derive from the fact that in educational programs the greatest emphasis is on curriculum; that is, the imparting of a body of knowledge to the students. This orientation means that the stress is almost solely on *what* is to be offered and not on *how* the material is incorporated (or not incorporated) by the student once it has been made available to him. This view is reflected clearly in the near universal plea for teachers to ask intriguing and varied questions. It is somehow implicitly assumed that once the question has been asked, it will stimulate the student and he will answer it correctly. In a group situation, this is usually true, for someone does eventually come up with the answer. Poorly-functioning children, however, have great difficulties in this regard. Even if they attend to the questions asked, they are bewildered and confused as to what answers are required or appropriate. Effective learning in this situation will occur only if the teacher recognizes their difficulty and helps them overcome it.

The existence and treatment of the wrong response has been one of the most grossly neglected areas of research in education. Wrong responses are a major factor (and a major stumbling block) in teaching efforts with handicapped learners. It, therefore, seems essential to develop procedures for a) assessing the teachers' patterns of responses to children's errors and b) assessing the effectiveness of these patterns (i.e., which help the children, which do not, etc.) In developing instruments of classroom interaction, it seems necessary to separate two features; one is the general tone in the classroom (e.g., are the children working well, is the class running smoothly, etc.), the other is the actual teaching (e.g., what are the cognitive processes that are covered; how appropriate are they to the children's level; how much time is spent in teaching, etc.) Many current assessments of teacher behavior are focused on the former issue. A well-run classroom is prerequisite if effective teaching is to be carried out. A well-run classroom does not automatically mean that the effective teaching is forthcoming. It is for this reason that I believe a distinction should be made between the processes of classroom management and those of effective teaching. The development of measures in both these areas are essential if we are to be able to train teachers to meet the educational needs of their pupils.

Summary

This outline has focused on the need for research in two major areas. One is the development of techniques for understanding the cognitive processes responsible for the difficulties of the learning impaired child. My own work in this area has led me to believe that a central and little studied area is the children's difficulty in the handling of complex, sequenced information (e.g., a reading passage) where the focus rapidly shifts so that a range of 10 to 15 major different cognitive demands might be made in a period of a minute or two. Because relatively few research techniques are available for studying the sequential organization of thought, basic research in this area is essential. Without it, we will

not be able to achieve progress on the applied issues on helping the poorly-functioning child. The second area in which I believe research should be conducted is that of program development and teacher effectiveness. Even if we understand the factors responsible for the children's difficulties, we are still faced with the predicament of not knowing whether the areas in which they are deficient a) can be developed directly, b) achieved through compensatory techniques that by-pass the difficulty, or c) whether the area be abandoned as a goal of teaching. In addition, we need information on the precise role that the teacher plays in helping the child's learning. In particular, we need precise measures on the effectiveness with which he or she helps the child over the points of difficulty he experiences (i.e., how effectively "the wrong response" is dealt with).

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THE BIOLOGICAL BASES OF COGNITIVE DEVELOPMENT

Susan Carey-Block

Normal Development

Discovering the biological bases of learning disabilities is only one goal in a comprehensive research program designed to help children who are relatively unable to learn. Attainment of this goal requires, among other things, precise behavioral description of the cognitive, perceptual, attentional, motivational, etc., properties of the child which are interacting with the school such as to preclude learning. This psychological analysis is also needed as a first step in any treatment program, behaviorist or not, for any individual child. Every paper in this volume pleads, explicitly or implicitly, for more subtle, comprehensive, insightful analyses of the exact nature of the problems. *What* is going wrong that prevents a child from learning to read? Are the problems social, cognitive, perceptual? If either of the latter two, what aspect(s) of the complex skill learned in schools are at fault? This paper is no exception in pleading for more adequate psychological characterizations of the problems. Searching for the biological bases of learning disabilities adds two things to the enterprise we are all engaged in. First, the biological context, especially work on brain damaged children and adults, provides a source of behavioral hypotheses. That is, functional systems have been isolated in this neurological work which cut across skills learned in schools in counterintuitive ways. Secondly, knowledge of the biological underpinnings of any child's problems further constrains the best ways of helping him or her.

In this paper I will argue that the biological bases of learning disabilities are best studied in the context of the biological bases of normal development. Concepts in the learning disability literature such as "maturational lag", and "incomplete lateralization" presuppose knowledge of the normal course of CNS development and its behavioral consequences. Paradoxically, in the present state of developmental theory, with a few notable exceptions, the contributions of biological factors to cognitive and complex perceptual development are virtually ignored. Indeed, data from children with learning disabilities can contribute to the knowledge of the biological bases of normal development. Even though the study of learning disabilities is already firmly grounded in its biological, primarily neurological, context, much more work on normal development in this same context is needed for the clarification and interpretation of these results.

Both of the main bodies of researchers in cognitive and perceptual development-the behaviorists and the Piagetians-are responsible for the underemphasis of the biological bases for normal cognitive development. In both traditions development is reduced to a few principles, and there is little motivation from within either theory for attempting to distinguish different skills and capacities and for attempting to study their developmental courses separately. Exactly that task is necessary for success.

In the case of behaviorism, concepts such as conditioning, reinforcement, discrimination, generalization, habituation and extinction are meant to account for the acquisition of knowledge in all domains-from language to social skills. I do not deny the power of these concepts, but they do not easily lead to the investigation of the biology of knowledge, except perhaps in the seeking of biological models for those basic mechanisms (e.g., Thompson's work on habituation). Of course, behaviorism is not incompatible with richer biological exploration. Take, for example, the case of motivation. Concepts like "drive reduction" or "reinforcement" apply to all motivation, but the interest of physiological work on motivation has come from the discovery of many different and interrelated systems-e.g., reticular systems, hypothalamic centers-each with different mechanisms and different developmental courses. We will want to do the same for cognitive and perceptual systems.

In Piaget's theory, like behaviorism, there are a few mechanisms of change (equilibration-assimililation and accomodation) which apply at all levels of functioning. One could study these mechanisms in a biological context (as was a major focus of Piaget's *Biology and Knowledge).* However, "equilibration" is the mechanism of change at all ages and for all domains of knowledge, so such study will not lead to theories of the biology of development of specific functions.

However, in contrast to the behaviorists, Piaget's theory mainly concerns the content of knowledge, and further, Piaget has no theoretical reasons to underemphasize innate factors; indeed, the first sub-period of the sensori-motor stage characterizes the innate organization of intelligence, on which further intelligence is built. Piaget's theories of the development of knowledge characterize the fixed sequence of changes with age in the intrinsic organization of intelligence. Lack of attention to the biological substrate would seem, at a general level, unexpected in a theory focused upon intrinsic organization. The reasons for this state of affairs can be found, I believe, in the nature of Piaget's stage theory.

Briefly, if the cognitive operations at a particular stage of development are equally characteristic of all functioning, as in the Piagetian view, there is little reason to look for any evidence that there might be specific parts of the central nervous system that could make distinguishable contributions to the early growth of cognitive functions. I will spell this out below.

In Piaget's theory, the child passes through 4 stages in the course of cognitive development. Each is characterized by certain properties of thought that were lacking in the earlier. Each of these properties applies to a wide range of cognitive behaviors. For example, in Piaget's early work, the pre-operational child's thought was described as egocentric. "Egocentricity" is applied to phenomena observable in the speech, in the playing of games, in reasoning about right and wrong in the representation of space, as well as a host of other aspects of the behavior of preoperational children. Or in Piaget's later work, where the logico-mathematical "groupings" were developed to characterize concrete operational thought, "reversability" plays a central role in the groupings underlying both relations and classification, and therefore affects the nature of the very concepts the child is capable of forming, his ability to make transitive inferences, his ability to understand measurement (and his concept of number), his understanding of causality. Thus a preoperational child, who lacks "reversability" will be immature in all of these domains.

The substages within a stage (e.g., the 6 substages of the sensorimotor period) also have this essential nature: each characterizes a wide range of behaviors in terms of the essential nature of the child's thought at that substage. For instance, stage 4 (co-ordination of secondary circular reactions) allows the combination of earlier developed schemata, so that the beginnings of means-ends analyses are possible. It is here that the child can first withdraw a screen to get an object hidden below it. Stage 4 also has consequences for the child's view of spatial relations. Stage 5 (tertiary circular reactions) allows, for the first time, relations among objects to be appreciated, so the child discovers relationships like "support". A consequence of this overall stage having been reached is that the child can now keep track of the relationships among a hidden object and two or more screens and thus solve stage 5 object problems (visible displacements). Stage 6 is characterized by the beginning of internal representation, and thus the child can now solve stage 6 object permanence problems (invisible displacement). The important point in the above account is that the behavior with respect to object permanence is seen as resulting from across-the-board properties of thought, which also determine the level of all other concepts the infant can entertain at each stage.

Recent work by Bower and his colleagues (see Bower, 1974, for a review) requires a total rethinking of this picture. First of all, Bower has shown that it is not permanence *per se*, nor belief that seen objects are solid and have tactual properties, that poses problems for the infants, even newborns (Bower, 1971). Rather, the child is troubled by a shorter memory for an object that disappears. Also, the infant cannot resolve as great a speed of disappearance as can an older child, and sees some disappearances as instanteous though they are really gradual (Bower, 1967). The development of these information processing capacities could certainly be purely maturational.

There are, in addition, according to Bower, truly conceptual changes with respect to the object concept. The child under 20 weeks does not realize an object-in-motion is the same as that object when it has stopped. He can monitor trajectories or stationary locations of objects but cannot handle the transitions between them (Bower, et al., 1971).

Bower's work is important for several reasons. First, it indicates that the immaturity on tasks which are taken to indicate that the child has no "object concept" is due to many causes, each of which is related to the biology of the child in a different way. Second, and more important, it fundamentally

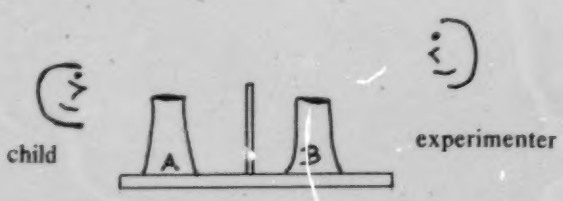
challenges Piaget's notion of the substages in infancy. In an important experiment (Bower and Patterson, 1972), Bower showed that training infants between the ages of 8-16 weeks advanced the age at which children reach the normal 20 week resolution of trajectory and place. This training also advanced the same infants' attainment, relative to controls, of stages 4, 5 and 6 object constancy (as measured by Piaget's tasks) months later. This implies that the object concept has "integrity". Although Bower did not test for this, it seems highly unlikely that the training he gave children during those weeks watching balls go behind screens would have sped up *all* of cognitive development, so that the child reached stages 4, 5 and 6 of sensori-motor intelligence as applied to all behavior earlier than did the controls. Thus it seems unlikely that the advances in the object concept during infancy are expressions of overall changes in thinking.

This should be tested systematically, for the question of general stages of thinking which are changing during development has profound consequences for the nature of the biological substrate of development.

There has been much work on the transition between pre-operational and concrete operational thought which leads to conclusions similar to Bower's on the object concept. Bryant and Trabasso (1972) have shown that information processing considerations account for some of the immaturity on transitivity tasks. That is, the child simply does not remember the two pieces of information A < B, B < C when asked the relationship between A and C. Presumably there is a purely maturational component to the improvement of memory. However, there are other differences between the young and old child with respect to this task. Young children seem to solve these problems of the component parts, and unlike older children they are not able to use knowledge of transitivity to construct solutions to measurement problems. (Bryant, 1974). Thus, as in the object permanence case, immaturity on transitivity problems is of several different sources and types, each related to the biology of development in different ways.

The "overall stage" characterization of intrinsic intelligent functioning is inadequate for this period of development, just as it was for infancy. Take, for example, the concept of "ego-centricity". The child below age 7 is supposed to be egocentric on tasks involving spatial representation, taking others' points of view in role playing tasks, speech, play, etc. Consider the following task: the child is shown a doll house and a tea party is set up. A shot glass, which is as big as the dolls, is brought out for the tea party and the child is asked whether it is a "big glass" or a "little glass". Children below a certain age maintain it is a "little glass." When asked, "That's right. For you it is a little glass; how about for the dolls?", they impatiently repeat *"A little glass."* Children over that age spontaneously take the point of view of the dolls, and answer "A big glass" to the first question. Now the behavior of the younger children is certainly egocentric in comparison to that of the older children, and thus this observation provides non-trivial confirmation of Piaget's proposition that young children are egocentric. However, the average age at which the shift occurs is 3 (Carey, unpublished data).

A similar observation has been made by the DeVilliers (1973). The experimenter asked children to look under the cup "on this side of the wall".



Children below a certain age chose their own cups, children above that age chose the experimenter's cup. Here the age cut off was rather sharply age 3 1/2.

Recent work by Huttenlocher and Flavell has indicated that the ages at which egocentric mistakes are made in spatial representation vary greatly with the task.

What lesson is to be drawn? First, as in the object permanence and transitivity cases, full analyses of the tasks in terms of the sources of difficulty are needed. Second, egocentricity is found, at least in

some of the cases, to be a powerful developmental concept. In tasks when point of view is an important component, younger children often take their own point of view. However, it does not appear sensible to talk about the young child's thinking in general, as egocentric before some age and not egocentric thereafter. And *that* is what is required by Piaget's stage theory.

Piagetians, of course, are well aware that different tasks which are formally identical are mastered by the same child at different ages (e.g., conservation of number is usually reached by age 6 whereas conservation of volume not until age 10 or 11). Piaget's word for this is "horizontal (i.e., within stage) decalage." However, the egocentricity-non-egocentricity shifts described extend way into the preoperational age range and thus across stages. Piaget has a name for this too ("vertical decalage"), but naming a problem does not diminish its importance as a serious challenge to one's theory.

The question of whether there are overall changes in thinking during development is an empirical one, and the answer to that question is crucially important to the biology of development. I have suggested above that there are no such overall stage changes which affect all of cognition and complex perception. However, the question is certainly still open. I will now consider the consequences of such a stage theory, if true, for the biology of development. I will suggest that for heuristic purposes it is better to proceed with research as if it were not true! The alternative view is of many different cognitive and perceptual mechanisms with different developmental courses. For example, some perceptual mechanisms may be feature detector systems having critical periods at different ages and may have varying degrees of plasticity during these critical periods. For other perceptual and cognitive mechanisms, differences in the commitment of relevant cortical areas at certain ages, or in the completion of connections between cortical areas, will cause differences in the details of development.

There are two extremes of biological models which could obtain if Piaget's characterization of overall stages of intellectual development were true. In the first, we might look for major changes in the CNS at the ages 2, 6 and 12, which might partially account for the intellectual reorganizations at those ages. Even if we found such changes (as indeed we might in terms of the effects of hormonal changes due to the onset of puberty, of the completion of myelinization, of sudden spurts of rapid axon growth, etc,) Piaget's stage theory would not necessarily be supported. First, one would have to be able to relate such concepts as "egocentricity", "reversibility", "concrete operations", "formal operations", to such changes. I submit that it would be almost impossible to relate the behavioral changes as described by Piagetians to any known biological mechaisms of change, nor to any known structural properties of the nervous system. Second, suppose that the second view of conceptual development (many distinct mechanisms with separate courses of development) is true. If there are spurts of change in the nervous system at particular ages, then these spurts might affect most, if not all, of these distinct mechanisms. On the behavioral level, this might look, superficially, like Piagetian stages. However, if it could be shown that this is merely a consequence of several distinct mechanisms being concurrently affected by the same underlying biological causes, the picture is really totally different from that propounded by the Piagetians.

The second biological model consistent with the Piagetial theory is that there are no maturational (or other biological) changes in the nervous system which affect intellectual restructurings. This, as I understand it, is Piaget's position. Of course, whenever any intellectual reorganization occurs (such as a scientist suddenly understanding his/her data in a new way, or the change from concrete to formal operations, if such a change exists) there must be some realization of the change in the nervous system. We do not believe in magic. However, it need not be that such changes are *made possible* by maturational changes in the nervous system. This is easy to see in the case of the scientist's reorganization; Piaget believes that the same principles of conceptual reorganization apply throughout all of development. I fully agree, for reasons which I cannot go into here. I differ from Piaget in feeling that such principles exhaust what can be discovered about conceptual development.

In summary, Piaget's stages of overall development are not fruitful sources of hypotheses for the biology of development for the following reasons: a) they probably do not exist, and b) they lead to no biological hypotheses or at most, c) they suggest a few ages at which to look for overall changes in nervous functioning, but they offer no hypotheses about what kinds of overall changes to look for. (Furthermore, overall changes in nervous functioning would be consistent with non-Piagetian theories of cognitive development.)

Both for heruistic purposes, and because Piagetian stage theories are probably false, I propose the opposite approach. Instead of looking for abstract, general, descriptions which apply to all intellectual functioning at a given age, one should choose specific abilities and analyze each in depth. It should be plausible that the capacities chosen be biologically meaningful. I would like to present a striking success within this approach emphasizing the essential ingredients for research along these lines.

The success I have in mind is speech perception, at the phonemic level. This case makes it very clear that discovering the biology of some capacity must *follow* a behavioral, psychological, description of the properties of that capacity. One way to procede in such discovery is to ask how that capacity is special. What properties does it have that other closely related capacities do not have? In the case of speech, perception is "categorical" (Liberman, et al, 1967). That is, there are sharp boundaries between phonemes. Two acoustic stimuli varying in Voice Onset Time (for example) by only 10 msec will easily be distinguished if one is on the "ba" side of the ba-pa boundary and the other on the "pa" side. Further, one cannot discriminate among different acoustic stimuli, all of which are heard as "ba", even if their VOTs vary by considerably more than 10 msec. Acoustic stimuli containing the same information in terms of VOT, or formant transitions, but not heard as speech are not processed categorically (Mattingly, et al, 1971) suggesting a special processor for input perceived as speech.

Although it has long been known that language is largely dependent, in normal adults, on the integrity of their left cerebral hemispheres, the discovery of the categorical nature of speech perception has led to the demonstration that the special processor for speech is localized in the left hemisphere. EEG recordings of evoked potentials to speech and non-speech stimuli show maximal peaks for the former in the left hemisphere, even for very young infants. Also at least some aphasics do not perceive speech categorically (Blumstein, personal communication). That speech depends rather specifically on the left hemisphere thus becomes a parallel to the demonstration that it is "special" in a behavioral sense.

More important to the question of the biology of speech perception than the location of the special speech processor is the nature of the speech processor. There is behavioral evidence, from adaptation studies, that the categorical perception of speech is based on a series of feature detectors which are sensitive to phonemic features such as voicing and place of articulation (Eimas and Corbit, 1973).

Even if this current emphasis on the categorical nature of certain aspects of speech perception should be challenged, the hypothesis about categorical processing has been a powerful heuristic. It has permitted experimentation on whether animals process speech like humans, and whether infants process speech like adults. The answer to the latter question is most certainly yes, at least by one month of age (Eimas, in press). Furthermore, the placement of speech perception in the context of feature detectors raises new developmental questions. Are there critical periods as in visual feature detectors, in which the presence or absence of certain stimulation determines their particular nature? Are all human infants born with detectors for the full set of phonemic features present in all human languages, losing those which do not reflect the phonemic distinctions in the languages they speak? Work has been begun on this issue; the results as yet are equivocal (Eimas, in press.)

There are several lessons to be learned from the speech perception case. The first is the importance of experimentation, at a purely psychological level, on the nature of the perceptual or conceptual processing. The second, is the range of biological questions which may be asked: is the capacity special to humans, does it have special properties which differentiate it from other human capacities, is it selectively impaired by lesions, and what is the course of its development? All of these questions are intimately interrelated—knowledge about any one suggests questions to ask relating to the others.

My colleague, Dr. Rhea Gendzier, and I have recently begun to carry out this program with respect to a quite different perceptual ability—face perception. We are not concerned with the question of how infants come to distinguish faces from non-faces. Rather we are interested in the recognition of familiar faces and in the process by which an unknown face becomes familiar. There are several reasons for studying this particular aspect of perception. It is certainly possible that there might be a special processor for faces, since face perception is an important human social skill. A normal person's capacity to remember faces is very large: we recognize thousands of people as familiar (public figures, school mates and colleagues, friends and family). I know of no other perceptual skill which demands keeping separate so many *individuals* from such a large pool of extremely similar stimuli.

There is good evidence that the right cerebral hemisphere plays a crucial part in the recognition of faces. In normal subjects, shorter latencies specifically for the identification of faces have been associated with presentation of stimuli in the left visual field (Rizzolati, Ulmifa and Berlucci, 1971). Similarly, an advantage in accuracy of a same/different judgement has also been shown specifically for faces presented to the left visual field (Hilliard, 1973). Additional evidence that the right hemisphere plays a critical role in face recognition is a study of split-brain patients (Levy, Trevarthen and Sperry, 1972) for whom the half face presented tachistoscopically in the left visual field determined subsequent non-verbal matching.

Studies of patients with selected cerebral lesions further implicate the right hemisphere in face perception. Patients with lesions in the right posterior cortex are severely hampered, when compared with normals or patients with other cerebral lesions, on several face perception tasks. Typical of these tasks are those which require matching a photograph of an unfamiliar face with photo-raphs of the same person taken from a different point of view or with different illumination, or wearing different clothing (Benton and Van Allen, 1968; Warrington and James, 1967; Assal, 1972). These patients seem to have difficulty abstracting the essential configurational representation of a face from the information presented in a single still photograph.

Thus, face perception is specialized at least in so far as being a right hemisphere function. Of course, face perception might be simply a special case of more general complex visual processing localized there. The issue of a special processor for faces depends partly on the behavioral demonstration that face perception has properties other visual processing lacks. Rock (1974) has shown that photographs of familiar faces are unlike most other visual stimuli in that they are extremely sensitive to inversion. One cannot phenomenologically right an inverted face, and it is difficult to recognize an inverted photograph of a familiar person (see Rock's example of Roosevelt). This is not true of many other mono-oriented stimuli, including geometrical figures and common objects. It is not, however, unique to faces, as it is not possible to phenomenologically right inverted text, and it is extremely difficult to read inverted text, especially handwriting. Similarly, the process of making an unknown face familiar is severely impaired by certain stimulus transformations (inversion, photographic reversal, Yin, 1969; Hochberg and Galper, 1967; Galper, 1970). Yin (1969, 1970b) has demonstrated that faces are *specifically* vulnerable to inversion. Although recognition of other mono-oriented stimuli, such as houses, bridges, costumes, and stick figures of men in motion, is also impaired when presentation and recognition trials involve inverted stimuli, the effect on face recognition is significantly greater than for these other mono-oriented stimuli. Yin (1970a, b) used this special property of face perception to delineate the exact nature of the deficit shown by patients with right posterior lesions. He showed that patients with these lesions do worse than patients with other cerebral lesions on recognition of upright faces, but better than the other patient groups on inverted faces. That is, for these patients inversion of the stimuli affects face recognition no more than it does the recognition of houses. The performance of patients with lesions in other cortical areas showed the normal adult pattern of selective impairment of face recognition by inversion. These results suggest that the patients with right posterior lesions represented unfamiliar faces and houses in terms of the same kinds of features. Presumably they cannot abstract that configurational description of an unfamiliar face which is orientation specific and which is adequate to subsequent identification of the face.

Young normal children, like adult patients with damage to their right posterior cortex, have great difficulty forming a configurational representation of an unfamiliar face. Saltz and Sigel (1967) found that six year olds were three times as likely as adults to deny that a new photograph depicting the target person with a different expression of head tilt was the same person. Rhea Gendzier, Brian Woods, and I adapted Yin's procedure with faces and houses. We found six and eight year olds performed exactly like adult patients with right posterior damage. Inversion affected face recognition no more than it affected recognition of houses. The normal adult pattern was shown by 10 year olds. We interpreted our results as indicating that the young children represented faces as they did houses, in terms of individual features which could be extracted from inverted stimuli as well as from upright stimuli (Carey). Gendzier, and Woods in preparation.)

Two additional series of experiments indicate that children under 10 represent photographs of unfamiliar faces in terms of isolated features. When asked to choose which of 4 photographs of the same person resembled each other most, children under this age chose on the basis of such things as earrings, hats, or other superficial paraphernalia. Adults, like children over ten, chose on the basis of the expressions on the face (Levy-Schoen, 1964; also Trombini, 1968). This is a striking demonstration: the expressions were gross and so dominate an adult's perception of these faces that the bases for children's judgements are sometimes difficult to find!

It is possible that the children under ten were simply interpreting the task differently from adults. To guard against this possibility, Gendzier and I manipulated facial expression and superficial paraphernalia in a task requiring children to judge which of two photographs depicted the *same person* as a target photo. Ours were gross expression changes and gross paraphernalia changes—large hats, wigs, bandanas across the forehead. Even adults made errors on 10-15% of the items. However, the patterns of errors made by children under 10 and by adults were totally different. Although explicitly warned of the transformations we would make, and told to look at the face, children under 10 found it difficult to abstract a representation of a face under these circumstances, and were heavily influenced by superficial paraphernalia (Carey & Gendzier, in preparation).

Thus age 10 appears, from three different studies, a turning point in the development of a schema for face recognition. In all three studies, there is rapid development between the ages of 6 to 10, the adult pattern being reached around that age. One possible interpretation of this developmental discontinuity is maturation, in the right cerebral hemisphere, of a specialized face processor. Another, compatible, possibility is that by age 10, in normal children, the commitment of the right hemisphere to the functions it will subserve in adulthood is complete. This entails a loss of plasticity that was present earlier, plus a general improvement in right hemisphere tasks beyond that age.

This latter interpretation receives provisional support from observations on subjects with hemidecortication, right or left, for brain lesions sustained in infancy. Kohn and Dennis (1974) examined a group of young adult hemidecorticates, none of whom showed obvious signs of right or left hemisphere deficits. However, when tested with more sensitive tests, young adults with no left hemispheres were impaired on tasks requiring the understanding of passive and passive negative constructions, whereas right hemidecorticates were normal on this task. Of interest to us here is the pattern shown by the patients with no right hemispheres. On a series of tasks designed to tap spatial abilities—Porteus and Wisc mazes, the Money map reading tasks, walking our a route on the floor, etc.—these patients were normal on some of them but impaired (relative to left hemidecorticates and to normals) on others. The property of the task which determined success or failure in this group was age of acquisition by normal children. If a normal child masters any of the spatial tasks used in Kohn and Dennis' study by age 10, adult right hemidecorticates also had mastered it; but if normal children master the task after age 10, right hemidecorticates never do. It was not merely a matter of having only half a cortex, for left hemidecorticates were normal on these tasks. This study suggests that the right hemisphere becomes committed to at least some of its specialized functions around age 10. Also, the left hemisphere does not have the capacity to subserve these functions, at least not if it is subserving the normal left hemisphere functions as well. This committment of the right hemisphere to its specialized functions could account for the observed loss of plasticity after age 10 with respect to language deficits resulting from left hemisphere damage. The committment of the right hemisphere to its specialized functions precludes its taking over left hemisphere functions (See Goldman, 1972, for an animal analogue in monkey frontal lobe development).

Among adults with lesions, the tasks Kohn and Dennis used are often impaired by damage to the left hemisphere as well as to the right (e.g., the Gerstmann syndrome, resulting from left perietal insult, affects certain spatial tasks.) There are several reasons for this. First, at least some of the tasks which diagnose spatial deficits are amenable to several different strategies for solution (including verbal ones) and can therefore be impaired through different lesions—This poses a problem in diagnosis similar to that posed by certain Piagetian tasks, such as the object concept problems, for which there are many

different sources of immaturity.[1] Tasks such as the Bender-Gestalt are particularly suspect, and should be avoided in attempts at precise description of a deficit. In contrast, there are relatively pure tests of spatial abilities, which can be specifically impaired by certain lesions, and which can be dissociated from other perceptual and cognitive tasks (e.g., Warrington and Rabin, 1970; Taylor and Warrington, 1973; these tasks involved discriminating such pairs as from or from). Second, it is likely that different tasks for diagnosing spatial ability are tapping totally different basic capacities, only some of which depend upon an intact right hemisphere for normal functioning. Thus, when discussing "spatial abilities" it is important to seek the purest tasks possible, and be perfectly clear that "spatial ability" is not a single entity, just as "egocentricity" is not a single entity.

Kohn's and Dennis' work suggests, tentatively, that the developmental discontinuity in face perception at age 10 may reflect a general commitment of the right hemispheres to their specialized functions at that age. I also suggested that there might be a special processor for face recognition which matures at that age. There is another possibility, intermediate between these two positions. It is possible that the deficits in face recognition associated with right hemisphere lesions are a special case of a more general deficiency in recognition of objects, recently described by Warrington and Taylor (1973). If so, it is also possible that the development of the face schema at age 10 is a consequence of maturation of these more general visual recognition abilities, and does not reflect maturation of some special processor for faces.

As Warrington and Taylor (1973) point out, deficits in recognition of sketchy drawings of scenes (Milner, 1958) and in recognition of fragmented drawings of objects and letters (Warrington and Taylor, 1973) have been shown to be associated with lesions in the right hemisphere. These deficits are not due to general intellectual impairment, nor to a visual field defect (DeRenzi and Spinnler, 1967). Further, they are not attributable to failure to discriminate single visual features like size, brightness, degree of roundedness, etc. (Taylor and Warrington, 1973). They are also dissociable from the simple spatial abilities tasks described above (Warrington and Rabin, 1970).

In a recent important paper, Warrington and Taylor showed that these visual recognition problems are not due to a difficulty in isolating figure from ground, since these patients could do as well as patients with other lesions at picking out an x of 0 from a background of visual noise. Rather, the authors argue that the deficit concerns "perceptual classification".

To show this, Warrington and Taylor prepared a series of pairs of photographs of familiar objects (a bucket, a clarinet, etc.). In one of the photographs, the object was presented from what one would intuitively agree was its normal or canonical orientation for pictoral representation (e.g. or .) In the other the objects were presented non-canonically (or) Normal subjects could identify every photograph, whether presented in the canonical or non-canonical view.

Warrington and Taylor then presented these photographs to patients with cerebral lesions. Patients with damage in the right posterior cortex (specifically, the inferior parietal lobes, roughly areas 39 and 40 in Brodman's classification) were impaired in recognition of the non-canonical views. This was in marked contrast to the pattern shown by some patients with damage localized in the left hemisphere. These patients had trouble naming both view, with no difference between canonical and non-canonical.

Warrington and Taylor interpret this deficit, along with the problems in recognition of sketchy and fragmented representations of objects, as a deficit in perceptual classification. Since face perception poses, among other problems, extremely difficult problems of perceptual classification (faces must be recognized from different angles, with different expressions, with different configurations of facial hair, etc.,) it is plausible that lesions affecting perceptual classification would also affect face perception. Gendzier and I plan to explore Warrington and Taylor's procedures developmentally, to see if there is a sharp improvement, between the ages of 6 and 10, in the ability to recognize non-canonical views of

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[1] In the light of the probable impurity of these tasks as pointers to right hemisphere damage in adults, Kohn's and Dennis' findings with hemidecorticates are extremely significant. They suggest that non perceptual strategies for solution are acquired later and depend upon the right hemisphere functions as a basis.

objects. If we find such a discontinuity in the rate of improvement at age 10, we will conclude, provisionally, that the development of the face schema which seems to occur by age 10 is a reflection of a more general maturation of visual recognition functions, presumably in the right cerebral hemisphere.

I have presented the face perception work so fully, not because I know the answers to the questions I am raising, but because it illustrates the success of the same recipe which was applied in the speech perception case. We see the relationship between behavioral analysis, work on patients, and developmental work. The discovery that perception of faces in normal adults is particularly susceptible to inversion was crucial for the interpretation of the deficit in patients with certain right hemisphere lesions, and for the subsequent discovery that children under 10 seem to represent unfamiliar faces as do patients with these lesions-in terms of individual, relatively isolated, features. This work illustrates, perhaps more clearly than the speech perception case, the usefulness of attempting to trace backwards, so-to-speak, into normal childhood, aspects of complex behavior that are selectively disrupted by certain focal injuries of the adult brain. In all cases the attempt is to dissociate behaviors from each other-in terms of their behavioral properties, their susceptibility to lesions, and their developmental courses.

Although the research strategy is the same in the speech and the faces case, the answers found are quite different. The issue of a special processor for faces is still open; the behavioral, lesion, and developmental work to date is at least consistent with there being a special processor. However, unlike speech, the proper biological context for the development of face perception is not one of critical periods for feature detectors, but rather seems to be one of maturation and commitment of particular cortical areas.

Part II Learning Disabilities

In this section I discuss, in broad terms, competing models for the biological bases of learning disabilities. For a detailed exposition of the current state of the art, see Rudel's paper in this volume. My purpose here is to demonstrate that the choice among the models must be made in the light of knowledge (presently lacking) of normal development.

There are three general models for the biological bases of learning disabilities. The first is that they are the expression of a general maturational lag in CNS development (e.g., Kinsbourne, 1972). Minimal brain damage (MBD) when thought to affect all of cortical and subcortical function is within this category. The second is a variation on this first—namely, that learning disabilities are the expression of abnormally slow differentiation of the functional areas of the brain (cf. Money, 1967; Bender, 1957; Critchley, 1970) or of abnormally slow maturation of the connections among functional areas of the brain (cf. Rudel, this volume). The third is that they are the expressions of specific abnormal syndromes, comparable in results if not in etiology to the kinds of syndromes observable in adult patients. These would include maturational lags of specific functional systems in the cortex (e.g., the developmental Gerstmann syndrome, Kinsbourne and Warrington, 1967 a, b, and c) and also highly specific syndromes which affect non-local functions (e.g., Prechtl's developmental choreoform syndrome, 1962). Hyperactivity, when seen as expressing the malfunction of specific subcortical mechanisms, is also in this third category. It is possible, perhaps even likely, that all three models apply, each to some cases of children with learning disabilities. In any case, which general model applies to any particular group of children with learning disabilities and, if the third model applies, which specific syndroms the children's problems express, is extremely important for decisions about treatment.

In at least some cases of learning disabilities, a pattern of overall slow development is apparent (cf. Blank, this volume). In some cases, children are slow to sit, to walk, to talk, are clumsy, are retarded at intersensory transfer, and have abnormal EEGs which show relatively infantile patterns (Money, 1967). It is not clear, from the accounts I have read, whether these children are also intellectually retarded in general. If their problem is truly an overall developmental lag, then they should be retarded, or at least have markedly low IQs (as is true of Blank's population). If the children are actually retarded, they fall outside the specific mandate of this conference. Also, the notion of overall developmental lag, like the notion of MBD, is not very useful in the absence of knowledge of the mechanism(s) by which the whole course of development is slowed down. Of course, if there is behavioral evidence that

such across-the-board syndromes do exist, research into the biological mechanisms should have a high priority. An additional problem with this notion is pointed out by Blank in this volume. If all that were involved is a maturational *lag*, then the children should attain the important skills *sometime*, only later. Blank stresses that they *do not*, at least with respect to certain higher order comprehension skills. At any rate, there is absolutely no doubt that specific syndromes, not affecting all of performance, also exist.

A disproportionate number of children with learning disabilities are left handed, or are mixed in their handedness, or have mixed dominance with respect to eye, foot, and hand preference. This fact is taken as evidence for abnormal lateralization of function, (c.f. Zangwill, 1962) and this in turn is seen as an expression of a general maturational lag in the differentiation of functional areas of the brain (e.g. Critchley, 1970.) Although the first inference is probably justified, at least with respect to speech, the latter certainly is not. But it is this latter claim which differentiates the "general maturational lag" associated with learning disabilities from simple retardation.

That abnormal lateralization of speech is associated with mixed handedness, or left handedness, seems somewhat well established (of Rudel, this volume). Zangwill points out that aphasias associated with right hemisphere damage virtually never occur in right handed people, although they sometimes occur in left-handed or ambidextrous people. He quotes Luria's claims that recoveries from aphasia associated with lesions with the left hemisphere are faster and more complete in left than in right handed patients. These results bear on abnormal lateralization of speech. Abnormal lateralization of other functions which in adults depend upon the integrity of either the right of left hemisphere must be independently established. Recently, normal adults who differed in handedness were compared on a face recognition task (Gilbert, 1973). The normal favoring of the left visual field was not found for ambidextrous people (as a group) and they were impaired on their performance of the task relative to both pure right and pure left handed people. These results are certainly evidence for incomplete specialization of a non-speech, lateralized function being associated with mixed handedness. In this context, Zangwill cites developmental problems with certain right hemisphere functions—poor drawing and copying, weakness in spatial orientation, uncertain discrimination of right and left—associated with left handedness and mixed dominance. But, as I pointed out above, these tasks are often not pure right hemisphere markers, so these deficits are not unequivical evidence for overall poor lateralization of right and left hemisphere functions. The relationship between learning disabilties and mixed handedness or dominance is an important one. The generality of poor specialization for normally lateralized functions should be assessed with several pure right hemisphere markers, such as face perception, perceptual classification (Warrington and Taylor, 1973), and others.

The inference from mixed handedness and impairment on some functions which are normally lateralized to a "general maturational lag" in all cortical specialization is tenuous. First, the concept "maturational lag" suggests that the specialization will eventually be reached, just later than normal. But this is not the case; ambidextrous adults certainly exist, and in at least some cases, incomplete specialization of speech and non-speech functions also persists into adulthood. Secondly, there is abnormally high incidence of left handedness or mixed handedness in both of the special syndromes described by Kinsbourne and Warrington (1967.) These syndromes are special just because they can be dissociated from each other, and thus mixed handedness in these cases is associated with specific maturational lags, not overall retardation in cortical specialization. Thus, much more work is needed to establish a class of learning disabilities resulting from general maturational lag in cortical specialization. Not only must performance on pure right hemisphere tasks be pushed back into normal childhood and then compared with abnormal childhood, but in addition, the specialized functions associated in adults with lesions in non-lateralized cortical areas must also be assessed.

In Part I, I suggested that clinical adult syndromes can play the role of suggesting specific abilities which might have developmental courses separate from those of other abilities. Quite obviously, clinical adult syndromes also suggest developmental counterparts which may the be bases of special learning disabilities. Kinsbourne's and Warrington's work on the developmental Gerstmann syndrome can be taken as a highly successful example of this approach. They succeeded in dissociating two entirely different syndromes of dyslexia (Kinsbourne and Warrington, 1967a, b, and c.) They selected two

groups of dyslexic children, one of which had verbal IQs (WISC) at least 20 points higher than performance IQs, and the other of which showed at least a 20 point balance in favor of their performance scores. The former group was found to have finger agnosia, to be impaired in arithmetic as well as reading and spelling, to be on the average even more retarded in spelling than in reading, and to have a constructional apraxia which affected the copying of geometical designs and letters. None of these was true of the latter group. Furthermore, the pattern shown by the former group mimics quite exactly the adult Gerstmann syndrome, which is characterized by spelling errors, finger agnosia, dyscalculia, and certain kinds of spatial problems. Adult Gerstmann patients are not typically dyslexic, but that is probably because their reading is no longer dependent upon the order relationships among individual letters, which is the heart of their problem.

These two groups of children correspond fairly closely to two groups of adult patients with spelling problems (Kinsbourne and Warrington, 1967b). In one group, the Gerstmann syndrome patients, spelling errors were characteristically order errors. In the other groups, aphasics, the spelling errors characteristically involved letter substitutions. Kinsbourne and Warrington report that the children in their Gerstmann group produce many order errors of spelling, sometimes coming up with anagrams of the target words. They do not report a study of the types of errors shown by their other group of children. Different patterns of spelling errors among different groups of dyslexic children should be sought systematically, and when found, should be related to others of their difficulties.

To pursue this line of research, Kinsbourne and Warrington had to develop a test of finger agnosia which could be given to children, and had to find the ages at which normal children could pass these tests. (Their finding that children under 5 or 6 had difficulty with these tasks suggests one maturational reason that it is difficult to teach children below that age to read.) For the purposes of diagnosing learning disabilities, it is important that the tests one uses will not be secondarily affected by the educational problems, or the emotional problems, the child has. Finger agnosia meets this requirement. Further, any cases where different *patterns* of errors can be found within a single educational skill, like reading or arithmetic, meet this requirement. In relating a pattern of errors to an adult syndrome, it is important to look for the whole pattern, keeping in mind that there will be obvious differences due to the logical relationships between skills in learning which are no longer present when the skills have already been mastered. For another example of this approach, see Rudel's discussion, in this volume, of developmental aphasias.

A close correspondence between a childhood syndrome in learning disabilities and an adult clinical syndrome does not imply the same etiology. Indeed, given the plasticity of the young brain, plus the reasonable expectations of different organization, the discovery of specific maturational lags such as the Gerstmann was quite unexpected and therefore significant for the general theory of the biological bases of development.

It is important to note that neither of the syndromes that Kinsbourne and Warrington described were specific to reading, spelling, or arithmetic. Nor is there any reason to expect any specific developmental dyslexias, dyscalculias, etc., since reading, writing and arithmetic are each analyzable into several different components, each of which might be related to different specialized capacities, or combinations of specialized capacities. Thus, hypotheses about which adult clinical syndromes might have developmental counterparts which are central to learning disabilities must proceed hand in hand with detailed analysis of the properties of the skills the child is failing to attain.

It has been asked (c.f. Vernon, 1957) why, if there is a general maturational lag of development, is reading most affected? Why isn't speech, or general cognitive functioning, also affected? This question is not an argument against there being a general maturational lag (although, as I argued above, that there is such a thing is yet to be established.) The answer to Vernon's question is potentially very simple: reading taps the *limits* of both linguistic and visual skills. More sensitive tests for linguistic and/or visual deficits might well reveal deficits in component skills (c.f. Rudel's paper in this volume; Kohn and Dennis' discovery of a subtle syntactic deficit in left hemidecorticates who were apparently normal in their language, etc.) The proper research strategy is to use tasks that are simple, subtle, pure and difficult enough so they might tap specific deficits. This must be done against a background of normal development. MBD, or general developmental lag, would be supported if such subtle, pure, deficits are

found in many different capacities and skills in the same child. Conversely, the specific maturational lag diagnosis of a learning disability is supported when these component capacities can be dissociated within a single child.

What are the component capacities of reading? Gibson has provided us with an elegant description of one aspect of the skill of reading (Gibson, 1967). In the earliest stages of learning to read, a feature analysis of the letters must be mastered. This involves learning to distinguish letters (or letter like shapes) in terms of the set of transformations which differentiate them. The ability to do this increases greatly between the ages of 4 to 7 (the same ages during which finger agnosia disappears in normal development.) It is possible that some children fail to learn to read in these early stages because of impaired spatial abilities of the sort described by Warrington and Rabin. The finding that higher order visuo-spatial tasks, such as the Bender Gestalt or the Kohs blocks, do not differentiate children with and without learning disabilities after age 10 (Critchley, 1970 has 3 possible explanations (other than spatial deficits are not important in learning disabilities, especially dyslexia:) 1) they are only important in some cases (of specific maturational lags), 2) the spatial problems apply only to this very early step of reading and do not figure into later problems with reading and 3) the spatial tasks used are not pure enough to produce a clear picture. I believe all three explanations are likely, and in the light of Gibson's analysis, further work in pushing back the clear spatial discrimination syndrome of Warrington and Rabin into normal childhood and consequent probing for specific learning problems related to this deficit merits further work.

The study of the higher order visual properties of reading has not, as far as I know, been applied to reading disabilities. It is here that reading taps the limits of certain visual skills. In fact, there is much evidence that reading is special in many of the same ways face perception is, and for the same reasons. First, it is common for reading deficits, as well as subtle face recognition deficits, to be the last residual symptoms of visual agnosias. In the adaptation to inverting prisms, text is never adapted. Further, Rock showed that reading, like face recognition, is different from other perceptual tasks in being more sensitive to inversion (Rock, 1974.) There is good reason for the similarity of faces and text in this regard. In both cases, features for identification are specified on many heirarchical levels. There are features which determine individual letters, but there are also higher order features which specify contours of whole words. It is well known, from tachistoscopic work with adults, that mature readers make heavy use of these higher order relational features (Neisser, 1967.) It is probably these relational features that are particularly upset by inversion, just as it is the configurational representation of a face which is hampered by inversion. And just as children below age 10 do not appear to use the configurational representations of faces, so too do they appear not to use the configurational representations of text (Frith, 1974; Goldstein, 1973.) That is, young children are upset by inversion of text much less than are older children. In the light of these similarities between face perception and reading, I consider it a high priority to look for developmental agnosias which could account for continued poor reading in older children. This must be done in the background of further study of normal children along the lines I outlined in Part I.

I will mention only one way in which reading places the highest demands on linguistic skills—in the domain of meta-linguistic judgements. It is a general developmental finding that children (or adults for that matter) often have skills without being able to reflect upon them. In the case of reading, this is disastrous. In order to understand the code that one is learning to decipher, one must understand that the speech stream is segmented into words (for that's where there are spaces) and that words are segmented into phonemes (for that's where there are letters.) Children below 7 have extreme difficulty with the latter and some difficulty with the former (Liberman, 1973; Sinclaire-de-Zwart, personal communication.) The difficulty with the segmentation into phonemes is shown on several different tasks. Children below six have difficulty learning pig-latin (Savin, 1972). They have difficulty tapping out the number of phonemes in a syllable like "bam" or "am" (Liberman, 1973). And they have difficulty with a task which requires them to "Say 'star;' now say it without the 's' sound." (Rosner, 1970.) Furthermore, Liberman and Rosner have found that children who still have difficulty with these tasks at age 7 are poor readers, and in an extremely important experiment, Rosner showed that training in these meta-linguistic tasks improved the reading scores of a group of first graders compared to a control

group who had started at the same low level on the meta-linguistic screening task. Rosner's experiment is important in that it highlights, once again, the importance of the relevant behavioral analyses of the requirements of a skill to treatment of children having problems with that skill. Also, it highlights a point made by Blank in this volume: often these deficits are far from absolute—a little extra training may bring a child up to par, and in this case, have the desired consequence for the important skill.

This work is related to the biological bases of reading disabilities in two ways. First, if some children have developmental aphasias of various sorts (see Rudel, this volume; Warrington and Kinsbourne, 1967), then their language skills might be in general backward, and thus not developed enough for the children to be able to reflect on their own language. This should be tested for in conjunction with other specialized tests for developmental aphasias. Second, a very specialized developmental aphasia should be watched out for. Some dyslexics may be dysphonemic (Critchley, 1970). They have difficulty making phonemic discriminations. Presumably these are children whose spelling errors should be marked by the wrong choice of letters rather than the letters being in the wrong order. The limit of this disability, if it can be isolated, should be tested to see if these children do not perceive speech categorically, as some adult aphasics do not. This would imply that the functioning of their special speech processor is fundamentally impaired, and such a group would be true "dysphonemics". Such a deficit, if it were to exist, would certainly not be reducable to a "maturational lag" since normal children have fully operating speech processors in infancy. It is extremely important to find out whether these children (true dysphonemics, developmental aphasias, developmental Gerstmanns), like those in Rosner's population, would so easily be taught to make meta-linguistic judgements. That is, are children who have diagnosable *specific* maturational lags like those children who have general maturational lags in being easily taught to overcome specific deficits? If not, we might reconsider thinking of these specific syndromes as maturational lags. Rather, they may be the reflections of more permanent differences among people.

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MULTI-LEVEL APPROACH TO RESEARCH IN LEARNING

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General Introduction

Underlying the approach to be presented in this position paper is the explicit assumption that learning is a basic characteristic of all living organisms, and a belief in the fact that the better able we are to understand the conditions which enable organisms with differing capacities and histories to expand their potential for learning, the better position we are in to tackle this most pressing problem today.

Given what we already know about the nature of learning and perception in the human organism, and given recognition of the varied populations the schools must serve, it is remarkable that today's educational establishment is rigid and irrelevant with respect to the varying cultures in which it operates. Rigid norms are built into this rather inflexible system, and each child is measured against these norms, regardless of his/her background and no matter what the curriculum (s) he has been exposed to. In this context, the application of the term learning disability to a child implies a deficiency in function between that child and some hypothetical normally functioning organism. The result of evaluation based on this type of comparison is the identification of the extraordinarily large number of children who fall outside the normal range as learning disabled, or any one of a number of other such terms. The demand of society that remediation be applied to this large group of learning disabled implies that somehow there is a fault in the children themselves—as if, following a medical model, they have a disease which we must cure. The aim of the cure, of course, is to make the children perform as the norms demand.

We believe that a new model of education must be chosen, especially at this time when education is becoming more widely available. The new model could generate a new definition of learning disability, based on a new definition of schooling. One of the goals underlying this position paper is the provision of an appropriate screening mechanism for the selection of research leading toward a more desirable kind of education. We would like to encourage those projects, both basic and applied, which have the best chance of contributing to the formation of an educational system which, unlike today's, will enhance learning ability, rather than produce learning disability.

We would like to suggest that education be defined in terms of a behavioral model which views the organism and the environment as constantly responding to each other and thereby modifying each other. Such a model offers the equal possibility of programming changes for both parts of the system, i.e., the child and the environment, depending upon the learning goals which are "deemed suitable"[2] for any individual in any context. Education in this sense of responsive environment does not require categorizing children as belonging to a disabled class. Rather, it deals with each child as he or she is found, using the child's own functioning as a baseline against which to measure change. Such a system, with proper assessment techniques, should also be able to handle the children who have learning difficulties based on intrinsic impairment of their perceptual, linguistic, or general cognitive processes. This is not to say that children with neurological disabilities will not need special treatment, but only that a system which provides for individual differences can also best provide for the extremes of these differences.

As a basic goal, this relational model of education, with its important stress on appropriate education of the individual, requires that research at many levels be carried on simultaneously. A number of distinct levels suggest themselves for study: the social context of the child both at home and in school; an

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[2]The goals deemed suitable in education will not be the focus of this paper. We would like to note, however, that the setting of such goals is really a political process and reflects the result of the sucessful translation into action of the needs and desires of many groups in the society. Unfortunately, there has not been enough self-conscious examination by funding sources of what the criteria should be for setting such goals for the society at large.

age specific analysis of those basic capacities of the organism which are relevant for intellectual functioning, as well as the development of techniques for assessing these capabilities for individual children; a fine-grained determination of the interaction of stimulus and response factors which produce the best processing of information in the human organism; curriculum development and its assessment based upon a funded review of the basic research literature on learning; and testing new models of schooling in real schools.

Usefulness of Integrating the Disciplines

Traditionally, the approach to learning disabilities has emphasized sensory and perceptual processes. Some theorists in the area, in fact, include perceptual dysfunction as a necessary component if a syndrome is to be labeled "learning disability." It is not our intention to restrict our view in this way, although it is certainly clear that sensory and perceptual difficulties comprise a large proportion of what are typically diagnosed learning disabilities.

Despite this emphasis on perceptual functions—surely one of the pursuits of psychology's mainstream—the field of learning disabilities has been all too often quite separate from the mainstream of the behavioral sciences. Although learning disabilities has been said to be an interdisciplinary field, with contributions coming from a spectrum of disciplines, ranging from the biological to the social, the characterization of a multi-discipline field rather than an interdisciplinary one has been more apt.

While it is true that many researchers and clinicians from a variety of backgrounds have worked in the field of learning disabilities, they have frequently worked only from their own point of view. Thus, many studies of maturational, biological, or genetic aspects of learning disabilities have been done without evaluation of the social milieu in which the disabilities occur, the familial status of the persons (usually children) who are the subjects of the work, and the like. Similarly, social milieu or school-oriented studies have been done without regard for the physiological or psychological status of the subjects. It would seem, therefore, that an important priority for future work in this area would be the incorporation of several types of variables in a single study, or in a series of studies. In short, then, although learning disabilities have been of interest to a wide variety of disciplines, as the literature attests, there have been some striking omissions (most particularly in the area of social context of learning). Let us now not only fill in some of the gaps, but encourage truly interdisciplinary work as well.

The Social Context of Learning

Following from the notion that schools have so institutionalized themselves that their resulting rigidity has become productive of individual learning disability, we would like to recommend instead that they become truly responsive environments. This means that they should no longer function monolithically and uniformly as if the group of children with which they deal is homogeneous. Instead they need to be made flexible and adaptable to the requirements of a diverse population, diverse not only in terms of age, developmental level, and individual capability, but also socially and culturally. Certainly a foremost priority should therefore be given to research concerned with investigating the social forms and processes directly involved in learning.

Within the social domain, we would like to suggest an alternative to the epidemiological approach, in which rates of failure in school, for example, are related to such social categories as class or ethnic group or migratory status. A more direct social orientation, with an emphasis on social networks, would include a wide range of more specific types of investigation: descriptive studies of classroom interaction; studies of adolescent peer groups in relation to school performance and in relation to speech styles; detailed quantitative interactional studies; studies of language use in relation to hypothesized familial network structure, among others. Very little in this area has developed to the point where firm conclusions can be drawn about what variables are relevant to what differences, but some important insights have been gained, and a strong expectation that work along certain lines in this area will be productive seems warranted.

We would like to give a brief sketch of the kind of relevance this area has to learning, including some reference to research findings, though with no attempt to review them here,[3] and to consider the strategic questions on which to focus at this time, and the variables and methods they call for.

One way to conceptualize this diverse social area is in terms of three related foci and their combinations: the learner's social history, the learner's ongoing social connections outside the immediate situation, and the social connections operative in the immediate situation (e.g., a classroom). ("Social" is used throughout to refer to definable sets of connections and patterns of interaction, not merely to a categorical label.) Cross-cutting this is what we will call cultural, again not referring to labelled membership in some set, but rather to what might be considered meanings—cues and reinforcements, modes of sequencing, interpreting, responding.

a. Social effects in infancy

It is in the child's very early social activities, that the initial system of significance—that is, of meaning—is acquired, on the basis of which any new exposures must first be interpreted before they can modify or be added in some fashion to that initial system. Although this is an ongoing process, its impact is probably greatest quite early. A great deal of work has been done on child-rearing attitudes; on mother-infant interaction patterns; there has been some speculation about the types of networks in which the infant and small child first learns; there have been descriptions of different cultural practices, including relative emphasis on verbal instruction, and the degree to which the child is an observer and/or participant in various adult activities; and particularly, there has been increasing study of children's early acquisition of language. We have, nevertheless, at the present time, no definitive knowledge of the critical social variables or the nature of their effects.

b. Familial social effect in childhood

At any age past infancy the child participates simultaneously in more than one set of social connections—e.g., a household set, a group of neighboring children, adult and child relatives. Interaction patterns in each of these necessarily differ, as does the child's position in each of them. Presumably it is here that the child must acquire his/her first approaches to responding to cross-group conflicts in the demands made on him/her, in the differing evaluations people make of each other, and perhaps most importantly, in the codes of meanings and values that are appropriate to each person. The role of value conflicts and conflicts between group norms might be illuminated by direct small-scale study of this quite universal phenomenon. Study of cross-group effects should take as key individuals all of those directly relevant—e.g., teachers, administrators, parents, as well as children.

c. Formal and informal social contexts

With respect to the social structure of the learning situation itself, a number of descriptive studies indicate that the prevalent formal school structure involves the students as many single individuals in interaction with the one teacher. This is, of course, never fully achieved, since any ongoing set of 30 individuals will over time develop sub-groups; but where the intended formal mode opposes such subgroups, their existence is a discipline problem rather than a learning instrument. This "many-one's" to "one" format also involves a special interactional pattern, in which, for example, the overwhelming majority of speech is in the form of output from the teacher, input (at best) to the child. The child's structured relationship to the substance he is to learn is almost exclusively, then, as decoder, only infrequently as encoder, although paradoxically he is often tested in formal situations somewhat more as an encoder. Further, very little direct attention has been paid to the effects on learning of this unbalanced interactional, or input-output, decoding-encoding structure. Small-group studies of task performance, personal satisfaction, and other variables strongly imply that this is the least desirable structure for any of the stated aims of the educational system. More rigorous studies are needed, however, not only of the classroom, but of the wide range of other situations involving explicit learning. (All human

situations involve learning in some sense; by "explicit learning" we mean only to distinguish the acquisition of skills, games, information, rules, and whatever else the researcher with the informants' help is capable of differentiating at any given time, from anything else that is also being learned but that we are not yet competent to study or not interested in studying.) These situations include people's homes, street groups, work groups, and non-classroom school groups, among others.

d. The need for basic information on social interaction

Probably among the most fundamental questions on which we need information are simply: With whom does the child interact? At what ages? How much variation is there in interaction among children, with how many adults and in what settings? With how many children, of what ages in relation to the one under consideration, and with what relationship to the child, to each other, and to the adults around that child? What seems most important at this time is not a survey—census data certainly exist on such elements as family size—but intensive study of a fairly small number of children in order to give some deeper information on variables which cannot be picked up by a survey (although it might be possible to do so after the main variables have been discovered by more intensive procedures). Studies of small networks suggest at least three types of network structure that may be important: bounded groups, interconnected but unbounded networks, and loose unbounded networks. (In other terminology, the relationship to these of communication patterns has been discussed at length by Bernstein (1971), for example, and to some extent by Labov (1972) and others.) However, as sparse as is the information on this for adults, it is virtually non-existent for children, although it is the basis of many assumptions made about them. Yet the inference may be drawn from both small-group studies and from the still slight evidence of socio-linguistic studies that both the mode and the substance of children's learning is affected by these variables.

e. Effects of patterns of interconnection on learning

This last point need not remain wholly an inference. It can be directly studied, initially in naturally occurring groupings, and subsequently, with the variables derived from those studies, by experimental manipulation. Family networks cannot be subjected to experimental manipulation for this purpose, but sub-groups of children in the school setting can often be. It should be noted, however, that although experimental work is essential for clarifying the relationships of variables, many issues cannot be approached this way, since both adult participation and an at least partially formal setting are unavoidable—although observation of children's informal groups also involves an adult, the intrusion need not be as basic.

In the study of the effects of social connections on learning, two approaches to formulating the dependent variables of learning are needed:

1. Networks and formal goals of learning—Any conscious goal of the educational system can be considered in its relationship to differences in the children's network structures. For example, reading facility can be examined in relation to home networks, peer networks (on this, see Labov, 1972), and most readily, in-school networks. In the last case, the networks can be systematically varied for size, age-span, pre-existing relationships among the children, or other variables; for the first two, differences can only be compared analytically.

2. Networks and informal learning—In addition to the known goals, it is important to do more open-ended studies, in which one can discover something about what is in fact being learned, and in what ways, in addition to (or instead of) what may have been intended. The school, for example, has, like any other institution, alternate systems of goals and rewards, some of them more powerful than the intended systems, and clearly some school children do learn to function very well in these systems. (One example is the distribution of monitorships, which determines who can be out of class or out of school without penalty—see Gutwirth, 1974.) Not only in school, but in any setting, a great deal of what is being learned is not specifically intended, and can be only partially formulated in advance. For example, if we want to know more about the influence of peer groups on more formal learning—i.e.,

how does what is learned in various peer groups differentially affect what is learned in school—we can consider studying variables underlying value conflict, opposing loyalties, and antagonistic or concordant meanings. But without first studying these questions fairly open-endedly, we are very likely to miss what may be crucial factors. Nonetheless, despite the open-ended nature of such observations, variables defining the group structure, its patterns of interaction, its connections with other groups, and so on, can and should be rigorously defined. Many aspects of the effects we think may be important can also be explicitly stated in advance. But the methodology should provide ample room for exploring other unexpected effects.

Methodological Concerns in the Study of Social Networks

It is appropriate at this point to make some general remarks about methodology in this area. In the inclusion of open-ended studies as an approach to trying to discover things we may not know exist, it should be said that we will discover very little if we do not insist on rigor. Certain network variables (like interconnectedness) that can be expected to be of general importance can be specified and defined with precision. Frequency of contact can obviously only be properly obtained through systematic observation; where certain problems require the full or partial substitution of reported frequencies, special attention must be paid to complementary studies of the amount and nature of the distortion introduced by this. Since networks are by definition connected sets, ordinary approaches to sampling are inappropriate, and must be carefully developed in the context of each of several types of studies.

Since the relevant issues require intensive information not only directly around the key individual but also around each of those who are important to that individual, and possibly further steps out, adequate study of even a single individual could be prohibitive. Thus several coordinated approaches are called for, including branching out several steps from a key individual on some relevant criterion, direct study of a group, working out one step from each member of a group, studying a full one-step set around an individual, and so on. To some extent the choice of approach will depend on the specific problem; but it is also necessary to direct a combination of these approaches to the same problem if we are to learn how they relate to each other.

One additional methodological point should be made. Simple theoretical assumptions can generate a number of testable expectations through hypothetical manipulations subsequently tested empirically. Serious attention should be paid to coordinating the design of separate studies so as to take advantage of the efficiency and power that can be yielded in this way.

Basic Research Questions of Importance for Studies of Perception, Learning, and language

In pointing research toward the development of more individualized and responsive schooling, we need to know a great deal about what factors aid in learning and what factors interfere with it. Perhaps rather than learning we should use the more general term, information processing, for learning has been traditionally confined to the area of conditioning within the context of basic research. It is only on the basis of such research that flexible enough curricula can be developed. While immediate applicability to practical situations should not be a criterion for investigation, basic research on information processing should be translated into practical approaches to curriculum development, teaching methods, and assessment techniques. In this way, schooling can become the result of a rational process.

The areas in which we advocate intensive research are not neatly orthogonal to each other because investigators in the overlapping and embedded fields of development, perception, information processing, learning, etc. have not conceptualized their problem domains in the same way. Nonetheless, we feel that the following are among the most promising areas: multimodal effects on learning; the role of feedback in learning; the development of orienting, observing, and search behavior; factors directing or controlling attention; development of memory and investigation of the factors which enhance it; organization and conceptualization of information (with particular emphasis on language); and finally, communication.

a. Multi-modal effects on learning

Single and multiple-modality approaches to learning and learning disabilities are examples of the next steps which could be taken in areas that have already been subject to quite extensive investigation. In recommending priorities in an area which already contains much work, greater selectivity should be exercised in funding such fields. At the same time, however, planned outcome of research can be much more specifically targeted in these better-known areas, and carefully designed studies can yield definitive information.

Specifically it would be important to answer questions relating to input overload and underload, interactions among preferred and nonpreferred modalities, and the like. For example, are there preferred modalities in individuals? Do such preferences differ between learning disabled and non-disabled persons? Are the preferences task specific, or do they cut across tasks for particular individuals? Do stimuli from two or more modalities simultaneously enhance learning, or do they result in confusion and greater disability? Are there individual thresholds for stimulus overload? Are there characteristic types of learning breakdown as a response to overload? What is the nature of interaction among modalities, and is that interaction specific to individuals or are generalizations possible about human learning in that regard? Such research would be important for the structuring of classrooms. For example, classroom teaching is typically bi-modal: visual and auditory. If research were to show that young children, say, or disabled learners respond better to a single-mode approach to new material, implementation of that finding should be made possible. Such implementation would also have the advantage of bringing other disciplines into focus, and thus would fulfill the priority for interdisciplinary approaches.

b. The role of feedback in learning

Another type of research to be done in the sensory-perceptual area is on the role of feedback—and the type of feedback—in learning. For one type of study in such research, the response class to be learned could be either perceptual or motor, whereas the feedback would be by means of some perceptual mode. This could be accomplished in a discrete, single-task, single-feedback manner, or in a continuous learning situation, with criteria of acquisition.

It has been shown that non-disabled learners of varying ages will learn to discriminate nonsense figures of minimal form with no external feedback, presumably because they become able to define the salient cues in the stimulus array. How might one insure the correct separation of figure and ground in the stimulus material to be learned? What might such research tell us about the variation in threshold factors in people with learning disabilities, or in people of varying ages or backgrounds or educational attainments? How much of successful learning is dependent on the correct perception of the salient cues in a stimulus? What proportion of learning disability can be attributed to a deficiency in such perception? It has been shown that severe retardates are helped to function in discrimination tasks when the relationship between stimulus and response mode is clarified (Zeaman and House, 1963). Might it be that non-retarded learning disabled persons could be similarly helped?

Such a research approach would be closely related to the modality-oriented work described above. The question of the relationship of modality of stimulus to modality of feedback is a potentially important one in the investigation of learning disabilities, especially if a lower level of functioning is found to exist in one modality and not in others. Also, it might interact with modality preference, if such exists. Is it more efficacious to present the stimuli to the preferred modality, or does more efficient learning result from the provision of feedback information in the preferred modality?

c. The development of orienting, observing, and search behavior

This area would be basically concerned with discovering the developmental sequence of the spontaneous occurrence of orienting, observing, and search behaviors, since it is upon such behavior that the very young child's sampling of his/her environment is based. Results in the literature are provocative. For example in infants (Bloom, 1974) it has been found that eye contact serves as a setting event for

learning. We are beginning to assemble evidence for differences in scanning and search strategies with age and for different kinds of children. Miller (1973) hypothesized for example that since such strategies improve with age, they allow older children when viewing stimuli for long durations to overcome perceptual biases that operate at brief exposures. There may well be differences in strategies between impulsive and reflective children. Egeland (1974) for example, found that it was more profitable to teach impulsive children to use search strategies than to delay responding.

Such behavior is controlled by stimulus factors which are concerned with stimulus salience and dimensional preferences and related to the ages at which children can use various types of contextual cues. Odom (1973) and others have mapped stimulus salience hierarchies for individual children and demonstrated their relationship to problem solving behavior. Medin (1973) has indicated that dimensional preference affects matching ability. A number of investigators (Brown et al., 1974; Kobasigawa, 1974; Campione et al., 1973; Baker, 1972; Klein, 1974) have found that younger children did not use available contextual cues until they were trained or instructed to. Stimulus complexity itself apparently has a differential effect on older and younger children in how much curiosity or playing time it induces (Switzky et al., 1974).

d. Factors directing or controlling attention

Another area deserves mention within this general field of sensory and perceptual functions, and that is vigilance or attention. Traditionally, vigilance is the term that has been applied to the ability to maintain a high degree of alertness in the presence of monotonous stimuli so as to detect a change or a relatively quiet signal. Attention has referred usually to an alerting mechanism and a bringing into focus of an immediate stimulus. A number of studies have shown that it enhances learning, and that certain factors can be seen to improve attention to relevant aspects of a stimulus.

Apparently, younger children may have problems in ignoring irrelevant information, particularly when it is salient (Pick et al., 1973). There is some evidence that younger children are helped by being given explicit information on what to ignore (Yussen, 1974) or when the stimuli are arranged spatially to focus attention on central stimuli (Wheeler et al., 1973). We need to know which attention focussing information is best for which processing of different types of behaviors. For instance, Silver et al. (1973) found that non-verbal feature emphasis is better than verbal for form discrimination. Mwanalushi (1974) found that imagery was better than naming for coding and reproducing spatial patterns. Furth et al. (1973) found that labeling functioned to call attention to static arrays at all ages. Wolf et al. (1974) demonstrated that children acquire associations better by producing interactions between the associated stimuli than by observing them. Koenigsberg (1973) discovered that visual cues were better than sensorimotor cues for improving letter reversal in young children. Various types of children may use various attention focussing techniques differently. It seems (Siegel et al., 1973) that reflective children use both visual and verbal labeling better than do impulsive children.

The findings in this area are very diverse, but provocative in their possible usefulness for enhancing information processing and thereby providing a rational base for the development of curricula.

In recent years, further subdivisions of attention have been made relating to "inwards attention" or "intellectual attention" as opposed to attention to an external stimulus. Vigilance and both attentional functions relate to learning, though perhaps in somewhat different ways. They also are apparently correlated with differential physiological responses (e.g., Lacy, 1967; Obrist, 1963; van Hover, 1974). The question of differing relationships between attentional functions and learning—or different types of learning—and the relationship to measurable psychophysiological changes deserves investigation as an approach to learning disabilities. This represents an area in which considerable research has been done in differing fields, with little relationship or interaction between the fields. Thus, while neurologists and neurophysiologists have been concerned with particular brain lesions or disturbances of function that might be associated with learning disabilities, they have not studied the psychophysiological correlates of such disturbances. On the other hand, psychophysiologists have studies these correlates, but with little regard for the learning problems of individuals. And scientists involved in human factors research

have contributed a substantial literature on vigilance and its relationship to stimulus arrays, for example, without much concern for individual differences or developmental factors. It would seem that putting some of this work together and carrying it forward with a focus on the learning process (information processing) and its disabilities would fulfill the need for greater coordination and amalgamation of findings from a variety of disciplines and at the same time contribute to the specific attentional, psychophysiological, and learning literature.

Another aspect of attention deserves some mention. That is, that some of the work in neurophysiology would seem to indicate that the organism must maintain a certain level of attentivity in order to receive stimuli (Hebb, 1958). Further, this would seem to be reciprocal, in that the absence of stimuli for a protracted period of time apparently has the effect of turning the organism off, and making it more difficult to apprehend new stimuli. In the field of learning disabilities, this might relate to the hyperactivity syndrome. In the typical vigilance experimental situation, stimuli are present, but they are of low intensity and tend to be monotonous. Does the learning ability of the organism influence his functioning in a vigilance-type situation? Does the stimulus mode relate to it? Does the presence of stimuli in one, two, or three modalities influence vigilance behavior?

e. Development of memory and investigation of the factors which enhance it

Here a number of basic questions should be dealt with. First, how does memory change with age (Perlmutter et al., 1974)? What are the factors that improve memory and how do they interact with age? Flavell and his colleagues (1970) have found that younger children do not produce a number of different appropriate mediators as well as older children and that, in most cases, such mediators can be taught and then utilized successfully.

There is the question of differences between the storage and retrieval of visual and conceptual (or verbal) information and the related question of whether younger children can better utilize visual rather than verbal cues (Yuille et al., 1973; Kosslyn et al., 1974; Furth et al., 1973). There are some basic theoretical questions on short-term memory versus long-term memory having to do with whether these are different or the same in adults and children (Peterson, 1963). And finally, how does memory differ with respect to materials which are or are not socially related to the child. For example, Genshaft et al. (1974) found that although both Black and White children could recall Standard English vocabulary, White children could not recall Black English as well.

f. Organization and conceptualization of information (with particular emphasis on language)

We know that coding has a positive relationship to information processing and we assume that it is due to the organization it imposes on the material. At what ages do we have evidence that children code? Conrad (1971), Halperin (1974), Hagen et al. (1973), Salzinger et al. (1969), and Furth et al. (1973) among many others have addressed the question of whether children code at early ages, and whether labeling and verbal coding are equally effective. The evidence appears to be that labeling serves a different function and is in fact sometimes an obstruction to information processing and that the use of coding, when it occurs or is induced (Moely et al., 1974), is effective and age related.

A number of investigators have addressed themselves to the problem of the emergence and use of verbal mediators (Kendler and Kendler, 1970; Kendler, 1972; Osler, 1973; Flavell, 1970; Hagen et al., 1973; to mention a few), and the literature is not clear. We need to look at mediation using other paradigms than the shift paradigm which has dominated the field.

Language effects on information processing are intriguing and in need of a great deal of work. Let us give some examples of questions which have been raised, all of which are relevant for our understanding of what messages both the structure and the semantics of language convey to young children. Brown (1968), Ervin-Tripp (1970) and Blank (1974) have examined the development of the way children understand various types of wh- questions—certainly a tool which we use unthinkingly in all teaching of children. Nelson et al. (1973) have successfully produced more category type questions in children when they were useful in acquiring information the children needed for information processing. Huttenlocher et al. (1968) have shown large differences in information processing depending on whether

the structure of a verbal instruction and the stimulus field were congruent for a child. Wetstone et al. (1973) examined receptive language for very young children and believe that when children are still nonfluent themselves, semantic constraints alone rather than syntactic constraints as well determine the messages a child receives. MacNamara (1972) has raised the question of whether one can separate syntactic and semantic constraints in trying to understand children's language acquisition. (Perhaps one should never teach grammar alone!) Clark (1970) has suggested that we look at the development of relational concepts because they are useful tools in the acquisition of further language. And finally, Schultz (1974) has begun some important work on children's appreciation of humor which indicates that modes of understanding vary with age.

g. Communication

If we are seriously to advocate an informal classroom, then we must understand more about how successful children are in conveying information and understanding the information that is relayed to them. Glucksberg, Krauss, and Weisberg's work (1966) is very relevant, and among other interesting findings, they have noted that children are more successful in communicating information which is labeled from their own verbal repertoire.

Very recently Garvey et al. published a study (1973) describing communicative speech in a nursery school. In one laboratory, Salzinger, using a somewhat similar design, the variables that make for communicative versus egocentric speech among 3 year olds in a nursery school classroom, have been examined.

Methodological Considerations for Basic Research Designs in the Areas of perception, learning, and language

In keeping with the heavy emphasis on perceptual dysfunctions in this field, there has been a great deal of research directed toward the sensory and perceptual processes thought to underlie learning and its disabilities. Therefore, in charting priorities for future research in these areas, it is necessary to be somewhat more selective than in those areas which have been less traditionally associated with this field. That is, when entering a previously cultivated vineyard, one must look over the remaining grapes most carefully; the same degree of selectivity is not required for the vineyard in which one is picking for the first time.

The primary investigative areas in perception and learning disabilities have been visual perception, visual-motor functions, and, to a somewhat lesser degree, laterality and left-right discrimination. In the last decade or so, auditory perceptual studies have come into more prominence. For the most part, these studies have been applied to or have been done in the context of disabilities in reading and general language skills, though there have been a few broader, normative approaches in the area (e.g., Belmont and Birch, 1963, 1965). The typical disability-oriented study in this field has involved the relating of particular perceptual, perceptualmotor, or laterality measures to a particular disability. Often other measures are also taken, and both the perceptual problem and the specific learning disability are related to such variables as social class background, age, birth order, academic subjects, or the like.

If more studies were to be done in this area, it would seem in keeping with the establishment of priorities that they be addressed to more unique problems, or that they proceed either down the level of complexity in a search for single-unit relationships, or toward the advanced complexity of multi-unit, multi-factorial studies.

1. Single unit designs—An example of a single-unit type of investigation would be to evaluate the relative importance of a single perceptual, motor, or perceptual-motor factor in the acquisition of a given skill. A study of this type should probably be replicated with various groups, such as individuals who had learning disabilities and those who did not, or with different social samples. The goal would be to determine the influence of single versus interactive variables on a criterion task. The experimental procedure might involve a cross-sectional design, using a substantial number of subjects, or it could be done with fewer subjects and a longitudinal type design. As an example of a cross-sectional design,

a particular task could be selected as the criterion, and then experimental groups constituted in terms of the skill to be measured. For one group, a "pure" perceptual skill could be measured; for the second group, a pure (or as pure as possible) motor skill would be evaluated; for a third group, a perceptual-motor skill would be involved; a fourth group could serve as a control, if the specific design demanded. That would be a paradigmatic cross-sectional design. A longitudinal approach to the same problem might involve the constitution of two experimental groups and one control group. For one experimental group, a pure perceptual skill would be evaluated in relationship to the criterion task; for the second experimental group, a pure motor skill would be evaluated. Then the first group would have a motor component added to the perceptual. Changes in the level of the criterion tasks would be measured and related to the nature of the given skill (i.e., perceptual, motor, or perceptual-motor).

2. Multi-unit designs—An example of a multi-unit type of investigation would be one in which a number of perceptual modes and response modes were tested in the same subjects and then the entire matrix of results subjected to factor analysis. After factor scores had been derived, evaluation procedures would be constructed for each, the procedures would be applied to a similar but different group of subjects, and the resulting attempt at crossvalidation would be evaluated. What is intended here is the subjection of perceptual and motor variables to a Guilford-type conceptual treatment. This suggestion illustrates another desirable approach to the field of learning disabilities: the application of methods and constructs developed in other areas of behavioral science to the problem of disabilities in learning. One priority for research now might well be to relate problems and methods to the broader body of knowledge and experiment. A multifactorial study designed on the basis of theory, and not merely as an empirical "fishing expedition," might be an ideal way to accomplish the true interdisciplinary work which was suggested as a priority above.

Methodological Implications of a Behavioral Definition of Etiology

The traditional approach to etiology is generally patterned after a "medical" or "disease" model with its associated search for a primary remote cause. Instead, we would favor a functional model of etiology in which "cause" is considered to be a complex interaction between the state of the organism and the environment. Furthermore, "cause" is useful only in so far as it is viewed not as a hypothetical construct, but rather as demonstrably and operationally related to the organism's current (functioning) behavior.

In keeping with a behaviorally oriented analysis, an etiological approach would specify the definition of a particular mode or level of perceptual functioning, and the relating of this mode to a particular mode or rate of learning a task or a skill. This differs from the classical clinical approach to etiology, which involves searching the behavior and skill of a subject until a deficit is discovered, and then relating performance on the learning task to the deficit. In the clinical approach, if no deficit is discovered, no individually relevant information is gleaned. In the behavioral approach, what would be sought, defined, and analyzed would be the relationship between particular perceptual modes of function and particular learning modes, and therefore the individual's learning processes can be better understood, whether or not he exhibits a problem. A priority for research might be, therefore, a fine-grained analysis of perceptual-learning relationships, including a search for what have been referred to as "mediating variables"—e.g., variables which exist between the specifics of the perceptual skill and the specifics of the learning skill. An example might best illustrate what is meant.

There is a well-known relationship between socioeconomic status (SES) and reading level, such that children from low SES backgrounds are at greater risk for developing reading disabilities. Once such a correlation is obtained and verified, very little more can be said. However, if one seeks out the mediating variables, a new research program can be mapped. SES is a global concept, as is reading skill. If one breaks down SES into, say, perceptual experiential background, and then also divides reading skill by type of errors made, one might find, for example, that children from noisy slum environments have greater difficulty in auditory discrimination, and that those same children make the kinds of mistakes in reading that could be attributed to faulty auditory discrimination of words. Auditory discrimination of words thus becomes a mediating variable between SES and reading skill. If one then further analyzes

the low-SES slum environment, it might be found that the ambience is a noisy one, and one in which there is not a great deal of speech directed to the children. So it might be that ambient noise and practice in listening are additional mediating variables. These specific—or more specific—variables might then be evaluated in terms of their relationship to the specifics of reading skill.

In terms of the view of etiology expressed above, the teasing out of this relationship would in fact be the analysis of the etiology of the reading disability in question.

Suggested Methodology for Assessment of Children's Level of Functioning Based on a Behavioral Model of Disability

A continuing problem, dealt with under a variety of rubrics in the past, is that of identifying individual skill levels and patterns of perceptual and perceptual-motor performance. We should like to broaden this concept from older concerns with "early identification" of learning disabilities, or simply classifying achievement levels: what is needed is a method of assessing individual perceptual skills easily and effectively so that learning curricula can be adjusted to suit individual levels and needs. If, as indicated previously, schools can become truly responsive environments with individualized curricula, then perceptual skill patterns would be important information on which to base the design of a child's school program. It would seem that a combination of such a profile, together with information about a child's progress in various curriculum elements, would be a superior approach to the current one which emphasizes standard group intelligence and achievement tests.

The approach being suggested would, in evaluating problems in learning, make secondary any attempt to define and attach to individuals diagnostic labels relating to disabilities. Instead, each child's profile would include information as to his developmental level, and curricula would be individualized both in terms of pattern and level. Such an approach would also be consistent with the current emphasis on "mainstreaming" (i.e., placing children in need of special education in classes with their nondisabled age peers for varying amounts of the school day): if each child in a given area were following an individualized curriculum based on his own pattern and level, then the child whose performance was at what might be termed a disability level would simply be working on his own curriculum. Only the most severely disabled learners would be placed in separate special education classes.

While it is recognized that devising a system of perceptual assessments which could be easily and quickly administered and which would yield the needed information, is not a quick or a simple task, it seems eminently worthwhile to encourage its inception. Some instruments and experimental work already exist which could be effective starting points for the work (e.g., Graham-Kendall Designs, Frostig programs, some reading readiness type tasks, etc.); a careful combing of the clinical and the experimental literature would undoubtedly yield more. The first step, then, might be a thorough evaluation and charting of past work, resolution of inconsistencies in findings, and development of paradigms which could be tested. Successful application of such an approach would also have the ultimate advantage of preventing those learning disabilities which issue from a poor match between a child's intrinsic perceptual patterns and the demands of the curriculum.

Summary and Conclusions

This paper has been based on the premise that learning disability, as it has been traditionally defined, is in large measure a product of our present school system. Furthermore, we feel that the idea of "disability" per se, coupled with an outmoded and rigid school system, has prevented children who have been classified as being outside the normal range from receiving the kind of education they could best profit from. Only for children who have measurable sensory and perceptual difficulties has remediation been generally successful, whereas for a large majority of children it has failed because it is an *ad hoc* and *ex post facto* procedure applied to a situation where rigidity has not allowed for the development of flexible curricula and teaching procedures suitable for working routinely with the differing needs of different children. For an enormous number of children whose backgrounds are discontinuous with the cultural norms of the school, the system has actually produced intellectual problems where we believe none need exist.

We are therefore advocating support for research that will provide appropriate materials and more sophisticated understanding to enable us to move toward a new concept of school which is no longer in keeping with the current structure in which a single teacher is expected to teach a single curriculum to a group of children. We would like to see all children who are not grossly physically and mentally handicapped schooled together in groups with fairly large age ranges. In order to avoid the detrimental procedure which has been known as "tracking," we would like to see "classes" organized like learning labs in various areas such as mathematical concepts, language arts, etc., which are set up with curricula adequate for use with a number of years' age-span and suitable for use with diverse cultural groups. In such a situation teachers would serve the function of assessing children's level of ability and achievement, organizing and choosing children's programs, monitoring their progress, and most importantly, stimulating and motivating children as they choose to work in the various areas. Formal classes with a single teacher would be set up only on an *ad hoc* basis when needed or requested.

Such a conceptualization forces upon us the necessity of providing multifaceted curricula which need not be taught in their entirety by a teacher but which are programmed so as to allow the children to move along on their own. Such curricula must be rationally based upon basic research on the factors which enhance learning in the areas of perception, feedback, observation and search behavior, attention, memory, organization of stimuli through various kinds of mediators and codes, and language development both as a self-regulatory behavior and a communicative behavior. Although some of these areas are well researched, others are not and demand that we be more selective in funding. Nonetheless there are many gaps which need filling—and we could well use a review of the findings pointed toward their use in the development of curricula.

In addition we need to gain an understanding of the effect of various types of social interaction patterns on learning, since working in such "labs" would give rise to varied types of formal and informal group structures. If we understood the communicative and reinforcing properties of such groups, we could utilize them in the establishment of classroom procedures which would enhance learning rather than deter it.

In keeping with the idea of school as a responsive environment, we need new approaches to assessment. We are advocating the development of profiletype assessments to be routinely used for all children, particularly in the areas of perception, language skills, and description of social variables so as to estimate their strengths and to place them appropriately into types of curricula.

Intellectual achievement would be gauged on the basis of the mastery of particular curricula. Achievement of curricula, therefore, would be tantamount to moving on to a subsequent level of difficulty and would eliminate the need for grading. Only for special purposes, such as entrance to new schools, would reference to national norms be needed—and indeed these need not be based on testing but preferably upon a profile of the curricula that a child has mastered.

With respect to network studies, we might mention a further application of network studies to problems of educational improvement. Although many of us talk about the areas of ignorance, in which we are badly in need of good research to know what affects learning, it is also true that there are many aspects of the learning process that are well studied, and which are nevertheless rarely successfully incorporated into an educational system. There can be little question that one pervasive obstacle to genuine alteration of the schools has to do with the complex of pressures mediated through a system of connections involving teachers, administrators, unions, legislators, and community. Direct study of this system of connections, and of possible changes in it, could play a critical role in the attempt to introduce *any* other kind of changes.

In looking toward an alteration of basic school procedures, we would also like to see, as future priorities, some real-school-applications of basic research, where new procedures and curricula based upon a behavioral model of schooling are applied and evaluated.

Furthermore, we do not believe that a scale concerned with evaluating the research as being applied or basic should be considered as a proper criterion for support, or whether the population studied is a "learning disabled" population. As long as the research can be shown to have relevance for modification, particularly for the expansion, of the capacities of the organism for learning—for acquiring the desired learned behaviors—that should be sufficient. One final stipulation should be mentioned. In an

effort to avoid a bandwagon effect in favor of covering a broad research base, we feel it important to realize that investigators conceptualize their fields very differently and that a number of approaches should be encouraged—so long as the variables with which they deal are explicitly and operationally concerned with learning. There is a lot that we need to understand and there is no way of knowing, at this point, whether the pay-offs will come from cognitive versus behavioral research; from RNA studies or imagery studies of memory; from study of the effect of the organisms' own responses versus the effects of other people's response on learning capacity; from animal versus baby research.

That kind of criterion should be avoided in favor of establishing criteria of excellence for the research designed. We believe that research in all areas discussed must be encouraged and supported, because of the complex nature of the problem.

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SYSTEMATIC INSTRUCTIONAL PROCEDURES: AN INSTRUCTIONAL HIERARCHY

Norris G. Haring

Introduction

At the Experimental Education Unit, recent investigations directed by Billingsley, Eaton, Gentry, Haring, Liberty, Lovitt, Smith, and White have yielded considerable data demonstrating that in order to provide optimal learning opportunities, it is necessary to arrange precisely the relevant instructional events. Each of the investigations has revealed, as one would assume, that there are differences among children in terms of the rate at which they acquire skills, the frequency with which they respond after a skill has been acquired, and the extent to which they generalize a skill in one response class to a new response class. Even though these differences exist, the investigations also suggest that certain basic instructional procedures should be followed with every child. For instance, in all of these investigations, which utilized a common research design and procedures—the experimental analysis of behavior—the following instructional conditions prevailed: 1) each child's performance was measured directly and regularly throughout the investigation; 2) all instructional events and teaching materials were systematically arranged for each child following a prearranged instructional plan; 3) reinforcement contingencies were arranged for each child individually, and the reinforcing events as well as the schedule or contingencies for these events were dictated by the child's performance; 4) instructional decisions were made regularly on the basis of the child's performance, which was accurately and graphically displayed.

The evidence from these investigations concerns the need for precise arrangement of instructional events. But what the evidence implies is the need for comprehensive and finer-focus investigation of those instructional events that facilitate learning. That investigation should include a series of systematic studies designed to determine what *are* essential instructional procedures, and how those procedures might be organized meaningfully so that they yield guidelines not only for instruction but also for evaluating performance.

Educators of both handicapped and normal children could become more efficient in their planning and instruction if they had a set of systematic guidelines to use in selecting instructional procedures. With such guidelines, teachers might avoid two well-known pitfalls. On the one hand, the selection of procedures has often been unsystematic, almost random. This not only reduces teachers' efficacy in working with individual pupils, but also virtually eliminates the possibility of evaluating children's performance changes as they relate to instructional procedures. On the other hand, teaching procedures have sometimes been so rigidly prescribed, as with espoused teaching methods, that teacher flexibility has been too restricted to allow for altering instructional procedures in order to accommodate individual differences in pupil performance.

An adequate framework or hierarchy of procedures available to teachers should provide a guide for systematizing their selection and for increasing the repertoire or alternatives that a teacher has for specific instructional tactics. At present, at least four classes of instructional procedures that teachers can employ have been identified and these almost classic procedures can be found in some form in almost every teacher-learner situation. These are: 1) demonstration and/or modelling; 2) drill; 3) a combination of drill and practice; and 4) application. It is important, however, to determine the varieties of experience within each of these and to explore variations from these classical instructional procedures.

Any discussion of a means to systematize instructional procedures—that is, to develop a hierarchy—must take into account the various developmental and learning hierarchies hypothesized by some investigators as well as empirical investigations into skill development and teaching.

Hierarchies of development have been formulated from a wide range of theoretical bases, and have been applied to a number of different skill areas. For example, the theory of distinct levels of cognitive operation and the processes of assimilation and accommodation formulated by Jean Piaget have already influenced recommendations about when to introduce certain concepts, notably mathematical, and the sequence for teaching them. New methods of psychological and educational testing have also been based on Piagetian concepts. Bloom's hierarchy of logical thought processes, from memory and comprehension through evaluation, has resulted in new methods of questioning students as well as the development of programs designed to teach those specific cognitive skills. The hierarchy of behavioral development proposed by Gagne, going from single reflexes through complex behavior chains, has affected not only the procedures used to teach new skills and to analyze tasks, but also the development of educational materi-

als. Although application of these hierarchies to practical educational pursuits is certainly incomplete, it is obvious that such comprehensive theories will contribute to the field, especially as a means of unifying the results of detailed empirical research.

Research into the nature of learning has resulted in the empirical validation of procedures, concepts, and distinctions which have affected teaching directly. The use of behavioral techniques, such as shaping and reinforcement for the control of behavior, is a direct outgrowth of laboratory work. The influence of research on the development of programmed materials and methods of educational evaluation is also evident.

Research and development in skill hierarchies have provided direction regarding the structuring of curricula and the sequence with which skills are selected and taught. Research concerning the factors which influence learning has assisted the educator in arranging procedures which have a high probability of affecting the learning process. It is unlikely that each skill is learned "instantaneously," however. Preliminary investigations at the Experimental Education Unit (for example, Gentry *et al.*, 1974; Smith, 1973) have indicated that distinctly different types of learning occur in the development of each skill through the phases of acquisition, mastery, maintainance, transfer, and generalization. These phases can be identified through fine-focus monitoring and measurement of pupil performance. Certainly the learner's movement through these various stages of learning could drastically affect the appropriateness of movement through a more general skill hierarchy. Similarly, it is unlikely that all of the various strategies and tactics which influence learning are equally appropriate during each of the developmental phases and the data from recent studies suggest that some instructional tactics *are* better than others during particular phases. Still, the amount of research concerning the development of individual skills has been extremely limited. Perhaps this area has been neglected because of the tradition of letting each teacher "discover" the teaching procedures that best suit him and his students. Perhaps the development of standard procedures to attend to the various stages of learning has been considered to contradict the concept now in vogue of "cognitive style." In any event, the tendency to ignore this critical link between research in skill hierarchies and research in learning occurs at the expense of both the student and the teacher. The empirical validation of specific teaching strategies which might possibly serve as basic facilitators for each phase in developing individual skills is imperative if we are to prevent guesswork from influencing the ultimate success or failure of the pupils in our charge.

Although some instructional procedures, such as drill and practice, have been recommended for developing particular skills, their place within a hierarchy of discrete task levels of skill development has not yet been ascertained. In addition, the specific functional relationships between the various stages of skill development and alternative instructional procedures remain essentially uninvestigated. Specifically, there is a compelling need to conduct research regarding: (1) the specific performance characteristics which delineate the points at which a task has been acquired, mastered, maintained, transferred, and generalized; and (2) the specific teaching procedures which are most appropriate for facilitating each of those learning phases. This manuscript has been prepared to discuss the present state of knowledge concerning those issues and to suggest current research needs.

Learning Phases

Acquisition

One of the first steps in any learning is to demonstrate initial performance of a target skill. However, if a learner responds only once, we cannot comfortably say that he has acquired the response in the sense that it is indeed a functional part of his behavior repertoire. The target behavior's first appearance and the "reasonably good" performance of the behavior form the boundaries of skill acquisition.

A specific level of performance accuracy has become a common criterion of skill acquisition. Educators accept the use of such devices as informal reading inventories and normative achievement tests both for diagnostic and evaluative data. Interpreting the results of these instruments usually involves an examination of the accuracy of the child's performance with respect to certain items or subtests. Different levels of accuracy might be acceptable for different skills. For example, some skills—such as spelling one's own

name—might need to be acquired at 100% accuracy, while a lower accuracy level might be acceptable for other skills, such as spelling the names of unknown persons.

Demonstration and modeling. Since a skill must be acquired before it can be mastered, maintained, transferred, generalized or applied, facilitation of the acquisition stage is obviously crucial. Empirical research supports the early use of demonstration and modeling in order to promote skill acquisition and both instructional procedures have been used extensively in schools. Demonstration may be defined as the teacher's actively performing a skill while the pupil watches and listens.[1] Modeling, on the other hand, involves presenting an example of the skill, or a pattern of responding to follow.

For example, the teacher demonstrates how to work a math problem on the blackboard, and then leaves the problem he has worked as a model for the students to use as they solve similar problems at their desks. In acquiring printing skills, the pupil uses a model of the letter to copy; he may also watch the teacher demonstrate the correct formation of the letter. Traditionally both of these procedures have been used in education. Logically, we would expect each to facilitate skill acquisition Empirical support for their use is now appearing in the literature. In a recent study, Smith (1973) showed that both demonstration and modeling were effective in teaching learning disabled children to perform certain types of math problems and that a permanent model (placed at the top of the pupils' worksheets) was a powerful tool during the acquisition phase of learning. Eaton, Lovitt, Sayre and Lynch (1974) found that oral previewing of material (demonstration of reading) effectively changed children's acquiring reading skills in new material. Developing imitative behavior has been fostered through the use of a model and reinforcement (Baer, Peterson and Sherman, 1971). Reinforcement and demonstration resulted in children's successfully acquiring imitative speech (Lovaas, Berberich, Perloff and Schaeffer, 1971). Researchers have applied these procedures to a wide range of behavior.

Several other studies recently completed at the Experimental Education Unit warrant mention here. The results of six studies (all N = 1) by Eaton, Von Christierson, Schoene, Lynch, and Doane (1974) indicate that cues were superior to drill in facilitating the acquisition of mathematics facts (addition, subtraction, multiplication, and division). These findings held true across processes and across children. Cues were superior not only for rate of acquisition but for the number of days required by the pupil to reach the desired aims. When cues were withdrawn, the pupils were able to maintain their previous high performance. For some children, cues were scheduled after drill had been unsuccessful and again proved their utility.

It is important to note that for those children who were not in an acquisition stage of learning (i.e., children who were no longer making errors but were still below their desired correct rate) drill was the superior tactic.

In a study by Liberty (1974), the use of demonstration and permanent model were effective in changing a thirteen-year-old boy's performance on subtraction problems. In addition, further demonstration or modeling were not necessary when the subject was presented with different problems of the same type, i.e., when transfer was exhibited. However, when the problem type changed, the pupil responded with an identical response to that learned for the previous problem type. Demonstration and modeling were again required to achieve errorless performance. This project suggests that a combination of demonstration and modeling will facilitate skill acquisition and transfer, although the learned response may interfere with responses to similar but slightly different stimuli.

Much of the research in skill acquisition is encouragingly specific and functional. Perhaps this is because the acquisition phase in skills development is impossible to overlook. If the learner fails in any way to demonstrate that he has acquired the skill, one cannot presume that learning has taken place. It was possible, in the study conducted by Smith (1973), to distinguish with repeated accuracy an acquisition stage of learning from a proficiency stage by inspecting the child's charted daily performance data. However, most research concerning skill acquisition has failed to distinguish that phase from subsequent levels of development (mastery, maintenance, transfer, and generalization). As a result, there are no guidelines that

[1]It should be noted that some children require instruction that goes a step beyond demonstration to physical shaping of responses. For instance, some severely handicapped children, or children who have not acquired the ability to imitate demonstrated behavior, may need hand-shaping and physical prompts and assistance to the point where they can make the desired response. The instructor, for instance, may need to shape a grasping response so that the pupil can eventually pick up and hold a pencil or crayon by himself.

would suggest at what point the procedures of modeling and demonstration might best be terminated in favor of more appropriate mastery-oriented instructional procedures. It might be the case that modeling and demonstration have evolved as generalizable tactics which attend to more than one level of the learning sequence; and that if the question of acquisition were considered in isolation, more appropriate, "specialized," tactics might be discovered.

Finally, research concerning "acquisition" has attended to the general issue of students' developing at least the rudimentary ability to respond in a specific fashion. But research has not systematically compared the strategies most appropriate for facilitating the acquisition of specific *forms* of responses. For example, does oral demonstration best facilitate the acquisition of skills requiring an oral response? Are skills best acquired singly or in combination with related skills? Should one skill in a sequence be fully acquired, mastered, and tested for maintenance before another skill is introduced or can the development of skills be "overlapped"? If skills are overlapped, how does this work? At what point should the second or third skill be introduced? The answers to these and other questions will have enormous impact on the ways we structure curricula; they should also enable us to maximize a pupil's potential for rapid growth.

Mastery

Once acquired, a skill must be mastered if it is to be functional in the individual's environment. That is, it is not enough merely to perform a skill; one must be able to perform it fluently and competently if the skill is to serve one well in all circumstances. The use of behavioral objectives, and the continuing importance of grades, illustrate the demand for skill proficiency in education, especially for basic skills. The recent onslaught of criterion-referenced tests supports the concept of skill mastery. Whatever we define as criterion levels, they involve not only the performance of the behavior (acquisition), but its performance at some objectively set level. Skill mastery or proficiency may not be definable except in terms of the role that the particular behavior will play in the individual's development. Each of the following may be definitions of mastery:

a. The performance of a skill at some level which insures maintenance of that skill. For example, reading a word such as "danger" is a skill that must be learned so well that it will not ever be forgotten.

b. The performance of a skill at some level which insures success in later or related tasks and skills. For example, the sounds of consonants should be learned well enough to facilitate their use in sounding out words.

c. The performance of a skill at some level comparable to that of others and/or peers. For example, an individual applying to medical school must be able to define chemical equations as well as others competing for places in the medical school.

Certainly additional definitions may be necessary. However, the specific skill-related definition of each mastery level will probably be determined through empirical research and a diagnosis of individual learner needs.

Drill. The traditional instructional procedure employed to facilitate this stage in skill development is daily drill. Drill may be defined as the repeated performance of a specific learned response.

One of the foremost principles in education is that we "learn by doing." Drill is essentially based on this concept. Much of the early research on this type of learning was summarized by Gates (1917). This research generally shows that requiring active, repeated responding (recitation) increases learning. Michael and Maccoby (1961) found that requiring a pupil to respond overtly also increased learning over requiring covert responses. Additional evidence to support the need for overt, repeated responding for learning is found in the work of Holland and Kemp (1965) and Krumboltz (1964).

Currently, research at the Experimental Education Unit is focusing directly on this area. Studies now completed indicate that drill is extremely effective in teaching a wide range of responses, from oral reading to manual communication (Eaton and Haisch, 1974; McGuigan, 1974).

As with research on acquisition, the greatest problem with "mastery" research lies in the fact that mastery is not usually distinguished from other levels of skill development. Most such research, for example, uses measures of retention as an indication of mastery—clearly a confounding factor in interpreting results. For instance, there may be some skills where drill promotes mastery, but where drill may not be the most effective or efficient means to promote retention. Further, one must ask whether a pupil can learn to

perform a task fluently and accurately, without his having the ability to recall it long after initial mastery. If the two levels of development are separable, then it is quite possible that instructional procedures most appropriate at one level are different from those appropriate at the next. Treating the two phases of development as one may or may not be detrimental to the ultimate utility of the skill; that remains to be seen. But attending to each separately may very well enhance the second, and might also affect the timing for introducing other skill tasks. More research is clearly needed to define the limits and observable characteristics of developing mastery (as opposed to maintenance) and the specific instructional procedures which are most appppropriate at this stage in a child's development.

Maintenance

Once a pupil has learned a skill, the next concern of educators working with the pupil is his retaining or maintaining that skill. "Having required S to learn a response to a given degree, or having asked him to repeat a response N times, we should concern ourselves next with the conditions which cause the functional strength of that response tendency to decrease" (Underwood, 1949, p. 509).

The most common procedure recommended to facilitate retention is overlearning. Overlearning has been defined to occur during repeated drill "beyond the point where immediate and complete recall is first possible" (Travers, 1967, p. 317). Many experimental studies, some completed over forty years ago (e.g., Krueger, 1929), show that overlearning improves retention. Overlearning as a procedure matches the definition of drill described here. Thus, this area of research may be interpreted as supporting the use of drill to facilitate skill mastery and maintenance.

Meaningful material, as opposed to nonmeaningful material, has usually been recommended for use with procedures that promote retention. For instance, it is clear from the research that more meaningful words will be learned faster and retained longer than nonsense words (Underwood and Shultz, 1960). However, the word "meaningful" may have different interpretations (Underwood and Shultz, 1960). It may mean that the material is familiar to the student (such as a poem utilizing familiar words), or it may mean that the material has many associations for the student. Finally, meaningful material may be material that is easy to organize, because the elements belong together in some unified structure. Perhaps it is this confusion in defining meaningfulness that has yielded unclear research results in this area. For example, basic studies have found one answer, but replications have failed to determine similar results (e.g., Katona, 1940, 1942, and Hilgard, *et al.*, 1953).

However, repetition does improve retention of organized meaningful material as well as of rote tasks. For example, college students who studied a scientific passage twice had significantly higher retention scores than a control group who studied the passage once (Ausubel and Youssef, 1965). Other studies have found similar results (e.g., Slamecka, 1960; Gilbert, 1957). Repetition through increased trials and days to criterion improved maintenance (Stinnet and Prehm, 1969; Eaton and Swenson, 1973). A high criterion level set for performance of a skill may also insure skill maintenance (Liberty, 1974).

Maintaining skills that have been taught is obviously important to educators, and the results of research in the area have provided clues for developing instructional procedures to facilitate skill retention. Although this topic has provided more research relevant to instruction than some others, there are still many questions left unanswered. As mentioned before, there is often confusion between this and other levels of development (e.g., mastery). If the phase of learning that leads to maintenance of a skill is treated separately, perhaps alternative instructional tactics will be discovered. Even if drill is the most appropriate tactic to insure maintenance, is it the same type of drill that was appropriate for developing mastery? How long does a skill maintain? What types of drill (e.g., using novel or routine material) will facilitate retention? Do criterion levels set for mastery affect the length, quality, or quantity of retention? Certainly these issues must be investigated in order to define adequately both skill maintenance and those instructional procedures which facilitate it.

Transfer

As educators, we assume that the skills we teach and knowledge we convey will be useful to the student throughout his educational environment. We also expect that many behaviors will be useful to and usable by the student as a member of society. For example, writing is not taught solely so that the

student will be able to write English in school; it is also taught so that he will be able to communicate effectively in his daily life. In addition, we assume that a skill learned at one level or grade in school will be transferred to other levels or to other skill areas. A child who spells words correctly on a spelling test will, we hope, spell those same words correctly in a report. Transfer can be defined as performing a skill in response to new stimuli similar to those used during instruction of the response. The actual response remains the "same" as the one learned, but the stimuli change. This definition may be slightly different from that of some educators, but the concept, as outlined above, is not. This definition is based on a precise behavioral definition of transfer, or stimulus generalization, which has been empirically developed. But the term stimulus generalization is not used because of possible confusion with skill generalization, discussed in the next section.

The instructional procedure most often recommended to foster skill transfer is practice. However, most authors fail to distinguish between practice and drill, although a functional distinction can be made. While drill is the directed repetition of the specific response to be learned, practice includes utilizing the learned response *with other learned responses* to solve a variety of problems. The responses remain identical to those learned, although the stimulus for the behavior varies or is combined with stimuli for other responses. Two types of practice might be identified from the results of empirical research. One type of practice may be called discrimination training, in which the specific learned response is taught to occur in the presence of certain stimuli, but not to occur in the presence of others (Catania, 1968). For example, the skill of addition is taught so that it will occur in the presence of a "+" but not in the presence of a " ". Practice of this type of addition would involve presenting a student with numerous opportunities to respond appropriately to both symbols. Transfer could be "tested" by presenting the student with problems having both "+" and "x" symbols, for example. Another example of practice might be requesting a count by ones of pennies, apples, and nails from a student who has mastered counting chips by ones. Transfer, and the effect of practice, can be examined by presenting other objects or symbols (e.g., ////////...) for the student to count.

Another type of practice is based on research in stimulus gradients (e.g., Catania, 1968). This research suggests that response transfer can be facilitated by reinforcing responses to stimuli while varying one essential aspect of those stimuli, such as duration or intensity. These results indicate that practice of another type should focus on that particular aspect of the stimulus which is important. This is the basis of Engelmann's (1969) statements about the teaching of concepts. An example of this type of strategy might involve repeated presentation of items that have "corners" with those that do not, as the student responds orally to questions about corners. Transfer of the student's skill in identifying corners could be tested by presenting a "new" item and asking if it had corners. Another example is routinely used in physical education: students practice catching balls of different sizes to facilitate transfer to many other sizes.

These two types of practice, discrimination and differentiation as they have been described, are based on empirical research on specific response learning. Research in which the procedures used to facilitate transfer were similar to those defined here as "practice" supports the use of the procedure in instructional settings. Kersh (1962) found that a group which practiced rules did better on measures of retention and transfer than did other groups trained in a "discovery method." Guthrie (1967) found that subjects taught by the "practice rules" procedure were able to apply that rule to new principles better than subjects taught by the discovery method. Briggs and Hamilton (1964), after a review of the relevant research, concluded that "In general, when tasks lend themselves to much internal cognitive structuring, the function of practice is to provide the occasions for such structuring. For rote learning, the function of practice is to provide relatively more instances. . .in order to strengthen the desired response, to dissociate it from conflicting responses, and to bring disinhibition."

In summary, research has pointed the way for instructional procedures to facilitate transfer, based on discrimination and differentiation training, and on repeated presentation in order to enable the student to form the rules and associations which are the basis of transfer. However, the confusion between the different tactics of drill and practice suggests that further research must investigate the relationship between specific instructional procedures and the transfer of basic educational skills, within traditional educational settings.

Generalization

Once learned, a skill must not only be useful in response to environmental stimuli similar to that under which it was learned, it must also be useful or usable in modified form in response to new problems or in new situations. Educators cannot teach specific behaviors for each environmental event or problem the student is likely to meet. The student must generalize appropriate responses from those in his behavioral repertoire. The individual must discriminate both the key elements in a situation and the appropriate response to those stimuli. These are "two basic component behaviors demanded by complex tasks." (Barrett and Lindsley, 1965) For example, when a person is driving a car there are several (learned) responses he can make when a car in front of him stops suddenly. He can turn, swerve, brake, or accelerate. He must make all of the discriminations necessary for an appropriate response decision very quickly in order to solve the "problem." Or, in another example of modifying a learned skill: in school, a pupil learns both cursive and manuscript writing. These skills are maintained in school, and, one expects, transferred to other situations (e.g., filling out job application forms). However, if the pupil breaks his "writing hand," he must generalize the skill of "writing"—in all situations —to the other hand. The response is a modification of the specific learned skill, based on changed or new stimuli.

Research (e.g., that of Baer and Sherman, 1964) has pointed out that procedures designed to affect one aspect of behavior can affect other (non-programmed for) similar responses. Further, variations of a response can be trained under different types of reinforcement schedules (Catania, 1968). However, what aspect of a response, or what related responses would be affected, cannot be defined only in terms of a particular individual and a particular procedure.

It is fair to say that without the ability to generalize, an individual has only the most limited control of his behavior and his environment, for he has virtually no way to extrapolate, to predict, to make deductions, and to reason. We have said that educators cannot teach specific behaviors for every situation a student is likely to encounter. But educators have a critical responsibility to insure that their pupils *learn how to generalize;* it is not a skill that simply "happens." A recent study at the Experimental Education Unit demonstrates all too graphically that there is need for generalization training for even the most rudimentary behaviors. Working with a mildly retarded young girl to develop her ability to make eye contact, Brush and Gray (1974) found that when "no attempt was made to achieve generalization of the behavior outside the experimental training sessions, virtually none occurred."

But with generalization, possibly because it is the most complex level in the hierarchy of skill development, we begin to see some erosion in the parallel of hierarchies. That is, while it is possible to show that certain instructional procedures "match" certain earlier levels of skill development, there is no sure "match" for promoting generalization. Possibly this is because in the acquisition, mastery, maintenance, and transfer stages of a student's skill development, the educator can focus on relatively discrete tasks. But by definition, to generalize means to move away from the discrete and specific.

Application. One strategy that has often been suggested to facilitate skill generalization is to give the subject the opportunity of meeting as many new and different situations as possible. This instructional strategy might be called *application,* and defined as a strategy providing opportunities to use or *modify appropriately* a previously learned skill in the solution of a new problem.

As an instructional strategy, application may be related to the research on problem solving, since the main focus of the procedure is to facilitate the application of learned skills in a new setting, or in response to a problem. People use many different strategies when confronted with a problem. The most common is guessing (Bruner, *et al.,* 1961); however, Ray (1957) found that asking the student to verbalize his strategy in problem solving often reduces inefficient trials. In another study, subjects who were led to follow a systematic pattern of problem solving were able to solve a task in a significantly fewer number of trials than the control group, who were not taught methods of problem solving (Goodnow and Pettigrew, 1956). Whimbey (1974) reports similar work by Bloom and Broder in teaching analytical thinking.

How feedback from the teacher or the problem administrator affects the individual's ability to solve a problem is a question that should be investigated. Johnson and Blake (1960, p. 60), in a study of learning in retarded and normal children, used limited feedback to their subjects while the pupils were

demonstrating their abilities to reason. "The subjects were informed as to whether or not each of their first 5 items were correct in each subtest and then finished the last 5 items independently. The purpose . . . was to aid the subjects in arriving at the analogies principle used without actually informing them as to what the principle was." In a recent Experimental Education Unit study (Hite, 1974, in Gentry *et al.*), a pupil received immediate feedback on his work by having his math worksheet corrected as soon as he finished it. He then reworked the problems he had missed. Having reached mastery in all phases of his one-column addition work in six or fewer days, the pupil quickly generalized to more difficult, two-column add facts, reaching criteria quickly.

Some research on the use of application has investigated the effects of practice where irrelevant though "realistic" cues were present. Overing and Travers (1967) found that practice in the realistic situation facilitated generalization to new situations. Anderson and Faust (1973, p. 375) state that "Later in instruction, when the goal is to teach the student to generalize in a broad range of situations, realism and a wide variety of examples should be employed."

As an instructional strategy, application is often used in occupational training courses, where the learning steps are designed to help the student meet specific requirements he must face on the job. Often simulated problems are presented for solution by the learner as tests of his ability to use the skills in a "real" situation. With ingenuity, educators could provide many other situations in which applying skills in problem solving should be tested. This instructional strategy is the "least used" in the present educational system. Perhaps that is because we have not yet identified appropriate procedures and methods for utilizing such a strategy. Certainly research has indicated some useful procedures such as having the learner verbalize his strategies and using structured teaching situations; but research investigating the relationship between problem solving and generalization, and in the role of application in facilitating those processes, must be extended. However, the research issues in this area are clouded by problems of defining the process of problem solving, tests of an individual's problem solving ability, and procedures which facilitate it (Travers, 1967). That problems themselves can be so variously designed is some indication of the scope of this topic for research. Kathryn Blake's excellent discussion of the dimensions of problems and of problem solving as an instructional procedure merits further attention. Some of the procedures she mentions for teaching pupils to solve problems are brainstorming, inquiry training, training for originality, training for associative fluency, instructions, and instructional programs (1974, p. 246). Clearly, the need for systematic investigation of these procedures as means to promote generalization is critical.

Finally, investigations are needed for answering such questions as these: What type of application fosters generalization of what skills? What quality of skill generalization can be trained? How can we define, and what are classes of, related behaviors? The answers to these specific research questions will ultimately decide whether or not the skills taught within the educational setting are fundamentally worthwhile in the larger community.

Present Research Needs

Although a great deal of research has concerned broad hierarchies of behavior and the effects of various instructional strategies on learning, it should be obvious that a gap exists in our information base when we begin to consider the development of steps or specific skills within the hierarchy. There is a critical need for research in at least four areas.

First, we must clearly define and differentiate between the various phases of skill development. Are the concepts of acquisition, mastery, maintenance, transfer, and generalization sufficient to describe the learning process? At what point might a child be considered to have "acquired" a skill, without yet having "mastered" it? How does a teacher *know* what phase a child is in? What are the behavioral or performance clues? Only when clear and functional distinctions have been drawn between phases of learning can investigators begin to consider problems of instruction and management appropriate to each.

Second, general strategies of instruction must be identified which are both effective and efficient facilitators of growth during each phase of learning. Much of the completed research bears either directly or indirectly on this issue, but the confusion between the various stages of learning often renders

the research results difficult or impossible to interpret. Is drill sufficient for acquisition, mastery, and maintenance? Does "overlearning" through drill promote transfer and generalization, or are specific types of practice required for those last two phases of learning? Until we know precisely when one stage of learning has been completed and the next stage begun, these questions cannot be answered. Nevertheless, it is imperative that we prepare teachers in those instructional strategies which will most appropriately influence the child's development across the broadest range of skills and learning phases.

Once the general instructional strategies have been identified that can apply in the widest range of circumstances, it would then be important to turn to more detailed questions regarding the relationship between specific instructional *tactics* and certain types of skill development. With what types of behavior, for example, does oral drill appear to be superior to written drill in attaining mastery? What types of skill can students maintain well if they have had only "overlearning" procedures in drill, as opposed to specific practice situations? Meaningful answers to these and other questions will be found only after the broad parameters affecting skill development have been identified. But research that asks such questions will be essential if we are to prepare teachers to provide children with the wide range of specific skills required by modern society.

Finally, after research has investigated the general and specific instructional procedures appropriate for the various stages of learning and for the wide variety of discrete task levels to be taught, it will be necessary to investigate systematically any learning that involves a number of skills at the same time. Are there certain skills which must be fully developed (to the stage of generalization) before subsequent skills may be introduced into the curriculum? Are there some skills which are best taught concurrently with others? Is there a functional interaction between the instruction provided during the acquisition of one skill and attaining mastery in a previously acquired skill?

Simply stated, it is essential that we determine how a teacher can identify the phase of development in which a child is presently functioning; and how he can determine which general instructional procedures are appropriate to that phase, and which specific instructional tactics will best facilitate the child's continued growth.

Implications for Education

The demands made daily on teachers and on the education system are enormous. Charged with individualizing instruction for students, today's teacher is faced with an avalanche of information from which to draw assistance. However, information on instructional strategies for specific phases of learning is not readily available. Research into those fundamental educational procedures which can efficiently and effectively facilitate skill acquisition, mastery, maintenance, transfer and generalization will provide information for immediate use in the classroom. The research will not yield theories or suggestions nor will it yield procedures and materials for very special situations. Rather, it will result in an empirical basis for common teaching procedures that can be applied in a wide range of situations. Not only will teachers benefit from this information, but each child will have the opportunity to learn in an environment in which instructional procedures can more predictably insure his success.

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APPLIED BEHAVIOR ANALYSIS AND LEARNING DISABILITIES: CURRICULUM RESEARCH RECOMMENDATIONS

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The purpose of this report is to suggest general and specific research topics that concern learning disabled youngsters. More specifically, the research topics will focus on curricular matters: reading, arithmetic, writing, spelling. Furthermore, Applied Behavior Analysis, a relatively new research methodology, will be advocated as the system for pursuing the suggested research.

Prior to describing the future research topics in learning disabilities, I have elected to offer first a few remarks about my conception of learning disabilities, followed by an explanation of the research variables included in this report. A brief description of the Applied Behavior Analysis research methodology will also be presented. This section will conclude with a justification for recommending this particular investigative approach.

Learning Disabilities

The classification, Learning Disabilities, has elicited more definitions than perhaps any other category of exceptionality. Often, the term learning disabilities has been defined by exclusion. That is, children are referred to as learning disabled if they are not mentally retarded, emotionally disturbed, or physically handicapped. However, it is not the intent of this report to discuss the relative merits of the various definitions.

The apparent rationale for defining pupils as learning disabled is to aid in grouping the children for subsequent instruction. The thinking is that if a group of learning disabled individuals can be placed together, a common treatment can be administered to them. Following upon this logic is the belief that once a common learning disabilities treatment is administered, the children will no longer be disabled. The fallacy of such logic is clearly evident in the fact that to date, a functional definition of learning disabilities that leads directly to a uniform treatment does not exist.

As to the matters of defining children as learning disabled and then searching for a uniform treatment, I must present the views of applied behavior analysts in this context. These opinions, since they form to a great extent the philosophical and methodological bases for Applied Behavior Analysis, should be fully understood to comprehend the research suggestions in this report.

The researcher or teacher whose developmental beliefs stem from Applied Behavior Analysis would not conceive of learning disabilities as a general trait any more than he would view psychosis as a general condition. Rather than attempting to define psychosis as a general condition. Rather than attempting to define psychosis or learning disabilities, he would point out certain behaviors that are abnormal. He might, for example, identify the inappropriate speech patterns of the "psychotic" client, and the *b-d* reversal problem of the learning disabled youngster. He would next determine the extent to which the behavior, inappropriate speech or *b-d* reversals, deviated from some norm. Following this baseline phase, the applied behavior analyst would then change some aspect of the environment in an effort to alter the deviant behavior. Rather than suggesting a single treatment for all clients with inappropriate speech or *b-d* reversals, he would recommend a treatment specifically appropriate for each individual.

Once those deviant behaviors had been dealt with, the applied behavior analyst, in his effort to normalize the individual, would define other behaviors that had perhaps prompted the definitions psychotic or learning disabled, and proceed to deal with them. The applied behavior analyst would define and prescribe treatment for one behavior at a time; he would not be so presumptuous as to deal with psychosis or learning disabilities.

In keeping with such a posture, I will present some of the characteristics of the subjects who served for much of the research discussed in this report. Generally, the children were of normal intelligence; their social and physical competencies were average. They were not able to read and write as well as other children in ther regular classes. Furthermore, their penmanship and spelling competencies, and their abilities to compute arithmetic problems, were often below average. The children were not physically handicapped and were not diagnosed as brain injured.

Variables to be Considered

The research that will be described and suggested in this report pertains to what has often been referred to as the basic skills. I have elected to describe research in six curricular areas: reading, spelling, penmanship, composition, arithmetic, and self-management. Several dependent variables from these areas will be identified and discussed.

Many of the independent variables in this report will be those commonly used as interventions in elementary classrooms. Some of these will be modeling, using instructional aids, feedback, and drill. Independent variables such as the presentation or withdrawal of positive reinforcement will also be considered.

Characteristics of Applied Behavior Analysis

In regard to Applied Behavior Analysis and curriculum research, I would like to characterize this system as comprising five ingredients: *direct measurement, daily measurement, replicable teaching procedures, individual analysis,* and *experimental control.*

Direct measurement. When Applied Bheavior Analysis techniques are used, the behavior of concern is measured directly. If the researcher is concerned with the pupil's ability to add facts of the class 2 + 2 = [ ], or to read words from a Ginn reader, those behaviors would be measured. This form of measurement is contrasted to more indirect methods that use such devices as achievement tests that measure behaviors not of immediate concern.

Daily measurement. A second important ingredient of Applied Behavior Analysis is that the behavior of concern is measured, if not daily, at least very often. If, for instance, the pinpointed behavior is the pupil's ability to add facts of the class 2 + 2 = [ ], he would be given the opportunity to perform the skill for several days during a baseline before a judgment is made. The reason for using several days' data is quite obvious; it might well be that on one day the pupil performed very poorly, the next day better, and so forth. Many times in research the pre- post-test methodology is used. A test is given before treatment and another is given after treatment. Judgments or decisions derived from such limited data might be pernicious; the consequences for some children could well be disastrous.

Replicable teaching procedures. Another important feature of Applied Behavior Analysis is that, generally, the instructional interventions are adequately described. In most instances they are explained in enough detail that other interested researchers would be able to replicate their studies. In contrast, other types of research sometimes explain general procedures only very casually. For example, one Brand X research study that used a phonics training program as an intervention simply said that "daily phonics drills were conducted." It would be impossible for an interested teacher or researcher to replicate such an investigation. In Applied Behavior Analysis research, if a phonics treatment was used, the reader would be informed not only about which phonics elements were stressed, and how they were presented, but about the amount of time used for instruction.

Individual analysis. The very heart of the Applied Behavior Analysis technology is that the data from individuals are presented. For this reason some have referred to this methodology as the Single-Subject method. In an Applied Behavior Analysis study, if data are obtained on five subjects, a graph of each subject's performance would generally be shown. By this means, all of the idiosyncratic behavior patterns become obvious. An inspection of these graphs would likely reveal that although the general effects on all five subjects might be the same, no two graphs of pupil performance looked exactly alike. Other research systems report the average data of groups—experimental and control. It might well be that these average scores do not represent the scores of any individual.

Experimental control. In every research study, regardless of the methodology, the researcher is obligated to prove that the effects on the dependent variable are attributed to the scheduled independent variable. He must establish a functional relationship.

The reason for establishing such a relationship is extremely important. For if researchers recommend that method C be used by all reading teachers because it was discovered that it improved certain reading skills, the researchers must be certain that variable C and nothing else caused the improvement.

Brand X reserachers often resort to statistical control in order to substantiate their claims. Their typical approach is to form control and experimental groups, give a pre-test, provide a treatment for the experimental group and no treatment or a placebo for the control group, then give a post-test following the treatment. The pre- and post-test data of the two groups are then statistically analyzed and the winner announced. The significance of the conquest depends upon which probability level was achieved: .05, .01, .001.

In contrast, the applied behavior analyst would use experimental control to establish relationships between the independent and dependent variables. More specifically, he would use some form of replication.

The ABA design has been the favored form of replication. During the first A phase no treatment is arranged. Then a treatment is scheduled throughout the B condition. In the recapitualtion phase the treatment is removed. If the behavior changed in the B phase from the first condition and changed back to its original level in the return to A phase, a convincing case can be made that a functional relationship had been discovered. There are other replication techniques available to the Applied Behavior Analysis research, such as the multiple baseline and crossover designs.

Beyond the fact that I believe the Applied Behavior Analysis system to be an excellent research methodology, in that it is responsive to such scientific characteristics as validity and reliability, there are additional reasons for advocating its use. One is its inclusiveness. Its techniques are flexible enough so that many of the important independent and dependent variables relating to the basic academic skills can be investigated.

Another very practical advantage is that when this system is used, one independent variable at a time is studied, with the attendant simplification of analyzing only one teaching procedure at a time. Several studies utilizing this system have demonstrated that many simple teaching procedures are as effective as other procedures that are more complex and expensive. Obviously, if a number of simple teaching procedures can be recommended, the training of teachers in the use of those procedures will be greatly facilitated. It would follow, then, that if more people can be trained to teach more skills, particularly the basic skills, there would be fewer educationally handicapped individuals as our product.

A fourth advantage of Applied Behavior Analysis is that, to my knowledge, this is the only system that can be used by both the clinician and the researcher. Let us note their procedures. Both would first clearly define the behaviors of concern. Both would then proceed to tally the frequency of those behaviors for a few days. They would next, possibly,change some aspect of the environment in an effort to alter the behavior. Both would graph the daily frequency of the behavior, and would interpret behavioral change from one day to the next in the same way.

The clinician and the researcher would differ only in matters of experimental control and reliability. As to control, the researcher would utilize an ABA or multiple baseline design in an effort to verify that his independent variable had affected the measured behavior. As to reliability, the researcher would occasionally schedule a second observer to scrutinize certain of his procedures. In spite of these minor differences, however, both can readily communicate with one another when Applied Behavior Analysis techniques are used. In the future, if more clinicians and researchers were to use such a compatible system, the teacher-researcher gap would be materially reduced.

STATUS QUO AND GENERAL RECOMMENDATIONS

Applied Behavior Analysis curriculum research pertaining to learning disabled children has been meager and desultory. Only recently have applied behavior analysts used this system to investigate curricular problems, and the few studies that have been published have not followed any systematic line of inquiry. Many investigators have shifted from one research area to another without providing substantive and conclusive evidence along the way. An exception to this touch and go method is the extent to which researchers have analyzed the effects of reinforcement contingencies. Several applied behavior analysts have demonstrated to the point of redundancy that reinforcement contingencies do influence the acquisition of many behaviors, by several varied types of individuals, in highly diverse settings.

The time has come, however, for applied behavior analysts to analyze systematically the many aspects of curriculum. For if meaningful results are to be achieved, researchers will need to concentrate their efforts on specific topics and not shift from one to another before conclusive statements and recommendations have been made. More will be said later about a proposed organization of researchers and teachers that should promote a more systematic approach to educational research.

Following are seven general areas in which curriculum research is greatly needed. There has been more research in some of these categories than in others, but in every area considerable research is still indicated.

Which Behaviors Make up the Subject Areas?

The subjects of education must first be defined. Applied behavior analysts have, like other curriculum researchers, focused their research on existing subjects such as reading, writing, arithmetic, and spelling. Although these categories have been accepted by grade school teachers and curriculum researchers for generations, it is possible that teaching and research would be more effective if other subjects were established.

Perhaps all educational subjects should be based on survival—in the home, in institutions, in the city. If the prophecies of Alving Toffler are heeded, the curricular areas would be determined by adaptability; of if Charles Reich's views are accepted, the raising of consciousness levels would be the primary subject.

Once the important subjects have been identified, the skills, traits, or whatever comprises those subjects must be labeled. The identification of those ingredients would obviously be a great aid to research.

In the area of reading, for instance, although applied behavior analysts have conducted studies on various elements, they have not provided a listing of the elements that constitute reading. Meanwhile, reading experts and researchers from other methodologies have identified some of the elements that make up reading. But their descriptions of the various reading skills are invariably vague. They are often so indefinite that precise research in their regard is difficult. To illustrate, certain experts have talked about such skills as "reading readiness," "initial reading," and "encoding." Although there has been considerable research in these general areas, the investigations have been widely scattered; few investigations have focused on the same precise skill. As a result, few substantial recommendations can be made pertaining to the behaviors of reading, in spite of the plethora of research. Applied behavior analysts, then, must clearly define each element of the subject of reading and the elements which make up the other curricular areas. Once that is accomplished, research about those subjects can be managed with relative ease.

How Should the Elements of the Subjects be Sequenced?

Once the ingredients of the major subjects are specified, analysts must next conduct research concerned with the arrangement of those elements. In educational research, debates have raged for some time about the order in which certain behaviors should be taught. In reading, some advocate that the names of the letters should be learned before the sounds. Others believe the sounds should be learned first. In arithmetic, some suggest that addition should be taught before subtraction and that both skills should be developed prior to the teaching of division and multiplication. Other arithmetic experts say that adding and subtracing should be taught simultaneously. Arguments have also focused on the sequencing of various penmanship, composition, and spelling skills.

A great deal of research should be conducted to determine whether there are, in fact, optimal sequences for the development of skills. Although the logic of sequencing is convincing—that one skill should be developed which in turn leads to another, then to another—it is possible that researchers will learn that many heretofore acclaimed "sequences of learning" are mere superstitions. It might be discovered through this type of research that in some areas the various skills can be developed in almost any order.

Researchers might also learn that sequence is individually relevant, that one sequence is better for one child, but a different order is better for another pupil. Indeed, a profitable pursuit for some researchers would be to investigate strategies for ascertaining these individual arrangements.

Research on sequencing is desperately needed in all the curricular areas: reading, arithmetic, spelling, and writing. The obvious importance of such research is that it would greatly serve today's need for developing non-graded classrooms and other educational plans where children are grouped by competencies rather than by age or other irrelevant characteristics.

Which Techniques Most Effectively Change Certain Skills?

Applied behavior analysts have channeled most of their energies into this type of research. In fact, as I have mentioned earlier, they have perhaps over-emphasized the fact that reinforcement contingencies can alter various academic behaviors. These researchers have clearly demonstrated that reinforcement contingencies can influence various reading, writing, arithemtic, and spelling skills.

Once the major elements that comprise the important subjects are specified, researchers can systematically concentrate on each element. If, for example, the ability to say or write certain blends is an established element in reading, researchers should examine the effects of several established and new techniques on the acquisition of that skill with many pupils. This type of exploration into all the skills of the various subjects should be encouraged.

When it has been determined which teaching techniques influenced which skills, researchers should systematically compare the relative effects of the variables. Occasionally, researchers set up research of this type before it has been clearly established that the techniques involved were initially effective. Little would be gained by studying the relative effects of ineffective techniques.

The contributions from this type of research would be far-reaching. If teachers knew which techniques were most suited for the development of certain skills, the probability of quicker remediation would be greatly increased.

How Should Performance Mastery be Determined?

In the first place, researchers must be more concerned with mastery than they have been in the past. Oftentimes researchers, including applied behavior analysts, have been concerned simply with behavioral change, without considering whether the change was effective. For example, in reading research, an experimenter might discover that a pupil's reading rate was 25 words per minute during a baseline phase. Then, during a teaching phase, his rate may have soared to 32 words per minute. Conceivably, if the mean scores or variances of the two conditions were compared, the investigator would be able to proclaim statistical or experimental significance. A teacher, however, might be unimpressed by such an experiment, for she might know that in order to be proficient a pupil must achieve a rate in excess of 100 words per minute. She might challenge the importance of the observed change. Some applied behavior analysts are beginning to take "real" effects into account when conducting and reporting their studies, but many more need to be guided by this important consideration.

Some of the research needed in regard to performance mastery might involve simply a careful explanation of the status quo. If, for example, reading or arithmetic research is being conducted with children described as having reading or arithmetic deficits, and the purpose is to send them back to a particular setting so that they will no longer be referred to as having those deficits, the procedure could be quite simple. First,the experimenter should pinpoint the exact behaviors that deviate. The next step would be obtain data in regard to these skills from a referent population. That population might be a third grade, a class for neurologically impaired, or whatever. If the referred pupil is expected to survive ultimately in one of these settings, then that situation is for him the norm. The obvious next step would then be to determine how discrepant the referred pupil was from the normal pupils in regard to the critical tasks. In order to determine the differences,the referred pupil's's rate or score should be compared to the lowest, highest, or most representative rate or score from the reference group. If the goal is to change the referred child's behavior so that it is like the median child's in the referent group,

then the median score is the goal. Following that determination, an intervention should be arranged in an effort to change the client's level of performance to the point displayed by the referent group.

Research pertaining to mastery level should also be conducted because of the possible effects of mastery level on retention and generalization. Later in this report, more will be said about these aspects of development, but within this context, it appears reasonable to say that both retention and generalization may be influenced by the level at which various tasks are mastered. In determining mastery levels required to promote maximum retention and generalization, the researcher will be required to approach the matter with more sophistication than was suggested earlier, where his intent was merely to change certain behaviors to conform to those of a referent group.

Research of this type would be of great importance to clinicians. Not only should the teacher know what should be taught and how; he must know the degree of proficiency to which the behavior should be developed so that the pupil will maintain that skill and generalize to other skills.

Retention Research

I mentioned in the preceding paragraph that mastery level may be a variable closely associated with retention, and therefore research concerning mastery level should be encouraged. A survey of curriculum studies conducted by applied behavior analysts revealed their disinclination to consider retention; very few studies used a "follow-up" component. To date, most of the investigations have been content to demonstrate merely that certain academic behaviors can be changed. Whether the pupil retained the ability to perform the behavior at a later date has been of little interest.

An initial suggestion for applied behavior analysts is that they incorporate routinely some provision for obtaining retention data in their studies. Beyond that, investigations should be arranged to determine the conditions or circumstances that influence the abilities of students to remember.

In addition to level of mastery, other variables may influence retention, among them the favored independent variable of Applied Behavior Analysis—reinforcement contingencies. Indeed, there are several ramifications of reinforcement procedures that might well be investigated, such as paying off pupils for remembering and penalizing them for forgetting. Other variables that may conceivably influence retention are modeling, feedback, instructions, and providing the client with various systems for remembering.

Researchers may learn that retention is a behavioral class, that if a person is taught to remember certain facts, he will be able to remember other facts. There is apparently some belief that memory is a general trait, for people are referred to as having good and bad memories. It might also be discovered that retention is situation-specific; that if the client is taught to remember one set of facts, this ability will not generalize to another.

Researchers may learn that certain techniques for developing retention are generally successful. Or, it may be found that some techniques are best suited to influence retention of one type while other techniques are more appropriate for other types.

Generalization Research

Although applied behavior analysts have carried out very little curriculum research on generalization, they have defined and conceptualized the term "generalization" so that research as to its implications is possible. Applied behavior analysts often refer to two types of generalization: response and situational.

Response generalization pertains to the transfer of a skill from one behavior to another. If a person learns to add 2 + 2, will that skill transfer to another addition problem? Some research has dealt with this form of generalization. We have, in fact, arranged some arithmetic studies to investigate two forms of response generalization, within- and across-class transfer. To test for within-class generalization, a pool of problems of the same class was formed. Instruction was provided for some of the problems, but not for others. If the pupil, following instruction, learned the non-instructed as well as the instructed problems, within-class generalization occurred. To obtain information about across-class

generalization, pupils were assigned problems of two classes. Instruction was provided for one class, but not for the other. If performance improved on both classes, across-class generalization occurred.

Categorizing arithmetic problems, or responses in other academic areas, into response classes, like subjects, must be defined for purposes of research and communication. Teachers and researchers must communicate with one another about educational matters—how various behaviors should (or should not) be sequenced, which teaching techniques are most effective for certain skills. With points of reference such as response classes, it is possible for teachers and researchers to collaborate and build upon the ideas and techniques of others.

Response classes are, however, arbitrary, since by definition a response class is any group of responses that simultaneously increases or decreases as a function of some variable. Therefore, a response class for some pupils might consist of many items, but for other pupils a response class is a small collection of items.

Since much of educational practice is based on the notion or expectation that response generalization will occur, a fair amount of research should focus on this topic. Applied behavior analysts should devise strategies to explore generalizations in not only arithmetic, but in reading, spelling, and other subjects as well. Further comments about generalization research are included in later sections in this report.

Situation generalization refers to the transfer of some skill from one place to another. As with response generalization, applied behavior analysts have neglected the matter of situational generalization. Several important studies could be arranged to assess and foster this phenomenon.

Since most behaviors are taught in isilation—reading during reading, spelling during spelling—it would be a simple matter to measure certain behaviors across settings. For example, the ability to spell could be assessed not only during the spelling period, but during the penmanship and creative writing periods. Once the level of situational generalization is known, then studies can be arranged to assess the degree of generalization.

As with retention, research in regard to generalization might support the fact that generalization is a behavior of itself: if a person is taught to generalize in one condition, that ability will transfer. Or, researchers might disclose that generalization is situation-specific. Further, it might be revealed that generalization is not a lasting ability, that people lose the ability to generalize. AS has been indicated earlier, it is quite likely that mastery level, retention, and generalization are closely related.

Logistics Research: Another Aspect of Generalization

This type of research has to do with a form of situational generalization: generalizing from research laboratories to classrooms. Research of this type must be conducted if the current method of instructing elementary children in the public schools is continued; that is, with several children per teacher.

A fair amount of curriculum research has taken place in situations where the teacher to pupil ratio is very low. For example, in the situation where I conduct research there are generally seven pupils and two full-time teachers. Occasionally some graduate students are used in the classroom to conduct special pprojects. Often our teacher-to-pupil ratio is 1:2.

Sometimes when we explain our instructional strategies to public school people, and particularly when we show them the daily data we obtain from all the pupils in six or seven academic areas, they are initially impressed. They appreciate the fact that we have a large amount of information about our pupils in several areas. Many of these visitors go on to say that although the measurement is commendable, they themselves cannot and should not be expected to use similar instructional strategies and obtain as much data as we do, since they have less help and more children in their classes.

Many teachers are frankly relieved to find an excuse for not using proven procedures and gathering daily data. Other teachers are truly frustrated; they would like to use better procedures and obtain measurement, but they are baffled by the task.

To date, the advice applied behavior analysts, including myself, have given teachers who have posed this dilemma has been slightly more then rhetorical and has fallen in one of two categories. We have suggested that they modify their current situations so that the probability of their being able to obtain measurement is increased, and have encouraged them to use pupil-management techniques.

In regard to the former suggestion, that teachers modify their situations in order that better procedures can be used and more data obtained, the following have been some of the recommendations: schedule certain times of the day for each measurement period, e.g., math or reading; measure for the same amount of time each day, preferably one or ten minutes in order to simplify the calculation of rates; use audio equipment to present certain items to the pupils, e.g., spelling words, math problems; precount the items on each page, e.g., math problems or words in readers.

As to our second suggestion, teaching pupils to handle certain of their own instructional responsibilities, the following have been some of the specific recommendations: that pupils time their own performances by using stop watches or timing clocks; that pupils correct their work by using answer sheets; that they count the number of correct and incorrect responses; that they calculate their own correct and error rates by dividing the frequency of responses by the time spent on the program; that pupils be shown how to graph their own rates, evaluate their progress, and select their own instructional techniques, e.g., drill, reinforcement; that they be allowed to set their own goals; that they be allowed to select what they want to learn, and when they want to learn it.

Although we mean well when these suggestions are offered and believe that if the recommendations are followed, teachers will be able to use better procedures and gather adequate data about the performance of their children, an established set of procedures for implementing these suggestions does not exist. Certainly no research is available in reference to these recommendations. Therefore, considerable research is needed to identify which teacher arrangements and pupil-management steps are most helpful. More information about pupil-management research is included later in this report.

Research of this type, determining which features of the classroom the teacher can redesign, and the many aspects of pupil-management, would be an extremely profitable research strategy for several investigators. Eventually, these efforts could be compiled into a workbook or manual wherein all the steps for arranging the setting and teaching various pupil-management skills were carefully detailed.

Teachers should management their classrooms by practices based on the research from curriculum researchers and from logistics researchers. From the curriculum investigators they will be able to incorporate the research that informs them of the best methods for teaching reading, penmanship, and arithmetic. They can measure the behaviors in each area the researchers suggested should be measured, use the recommended interventions to teach those skills, and advance from one skill to the next on the basis of the researchers' claims.

From the logistics researchers teachers will derive help in putting together all the pieces. Information from these people will help them to individualize the class so that all the pupils are working at their own levels, and to run the three-ring circus that is their classroom, where a dozen or so activities are going on at the same time.

Both types of research should be encouraged as should the blending of information from the two; for if teachers are expected to use proven procedures and document pupil growth, they must be furnished with techniques for implementing those practices. Teachers and other educators must also learn to discriminate between curriculum and logistics researchers. They must know where to go for which type of assistance. They must not expect all the answers from the same researchers.

STATUS QUO AND SPECIFIC RECOMMENDATIONS

In this section, comments will pertain to six subject matter areas: reading, spelling, composition, penmanship, arithmetic, and pupil-management. In each of the areas, a brief mention of the specific variables that have been studied by other applied behavior analysts will be noted. The inquiry will include a statement as to which behaviors have been measured and which interventions have been arranged. Next, a short description of the research conducted at the Curriculum Research Classroom will be included. Following this statement of the status quo for each of the subject areas, I will mention some research that should be conducted.

Reading

Applied behavior analysts have conducted a fair number of studies in the area of reading. The behaviors of concern in these studies have, however, been widely scattered. There has not been a concentration of research on any specific behavior, certainly not enough to provide conclusive statements to practitioners in respect to the instruction of those skills. Reading research is typical of the other curricular areas; as has been noted earlier, most applied behavior analysts have skipped from one topic to another. A notable exception to this desultory strategy for conducting research was Art Staats, who for a number of years concentrated his efforts in the area of reading.

Following are some of the reading behaviors that have been studied by applied behavior analysts. One of the most rudimentary behaviors to be investigated has been matching; investigations have focused on matching pictures or whole words with pictures or other graphic representations.

Other investigations focused on part words and whole words. In the former, the pupils were required to say various word elements such as blends or short vowels. In the latter studies, they were required to say words taken from basal series or from standardized lists. Other studies have dealt with oral and silent reading. A few studies were concerned with the comprehension or meaning of words or phrases.

Almost without exception the intervention scheduled in these investigations to influence the various reading elements was some form of reinforcement. Several types were used: praise, food, money, and trinkets. In some of the studies, token systems were established whereby pupils, contingent on a correct response, were granted something that was later redeemable for another item. In a few of the studies, reinforcement contingencies were arranged for correct answers, and some form of feedback or simple correction process was scheduled for incorrect answers. It has been the rare study that investigated the effects of variables other than reinforcement contingencies. One such investigation, concerned with the discrimination of part word sounds, appraised the effects of tactile differences.

Over the past few years at the Curriculum Research Classroom, we have measured several aspects of reading. We have measured various word elements, such as blends, vowels, consonants, digraphs, and diphthongs. We have also measured the performance of pupils as they worked in programmed readers. The bulk of our research has been concerned with oral reading, where we measured correctly and incorrectly pronounced words. Some of our studies focused on silent reading and others on various types of comprehension of orally and silently read material.

As to interventions, our interests have been broader than those of our Applied Behavior Analysis colleagues. We too have studied the effects of various reinforcement contingencies, such as giving something for correct responses and taking away for incorrect responses. In addition, we have explored the effects of many interventions which are commonly used in public schools. Two of these have been drill, both prior to and following performance, and instructions, simply telling pupils to do something. We have assessed the effects of remedial reading techniques like the Kirk drills and the Slingerland method. In several oral reading and comprehension studies we explored the effects of various previewing techniques.

Along with our interests in investigating the effects of several variables on specific reading skills, we have studied the relationships of various reading behaviors. Some of these have been between oral and silent reading, oral reading and its comprehension, silent reading and its comprehension, oral reading comprehension and silent reading comprehension, and between various types of comprehension questions.

One significant line of future research should focus on the overall development of competent readers. Some general comments that pertained to this point were made in an earlier section. Studies should initially determine each reading behavior along the way from beginning to advanced reading. Then, the techniques to develop those skills would have to be labeled, and finally the sequence or sequences of the skills would need to be arranged.

We have been engaged in some developmental research of this type with pupils who can discriminate all the part-word sounds and can read orally in beginning Lippincott texts. Our developmental plan has been to determine how best to advance pupils from a program wherein the primary emphasis was on oral reading to one in which the major concern was the comprehension of silently read material.

Our approach was to start the pupils in readers where they could adequately perform: their oral correct rates were fairly high, error rates were rather low, and when asked questions about the material they were able to respond. Once the children could read at their age and grade level, we required them to read orally and silently. They also responded to comprehension questions from both modes. During this time, if their silent reading rates were higher than their oral reading rates and if their comprehension of silently read material was satisfactory and equal to that achieved from orally read material, they were advanced to the next stage in the reading program. At this time they were required to read silently and answer many comprehension questions of several types.

Although this method of advancing pupils from one stage to another appears rational, there is scant data to advocate its employment in public schools. Continued efforts to develop a reading continuum would greatly aid reading instruction and could conceivably eliminate or at least change some of the great debates that have raged for so long in the field of reading.

A more specific area for reading research should focus on comprehension. There has been little research conducted by investigators of *any* methodology devoted to this important aspect of the reading program. Some reading experts have stated that several levels of comprehension exist. These range from recognizing facts from stories, to sequencing the happenings in stories, to identifying major themes, to categorizing certain concepts, to integrating what has been read with other material, to discriminating factual statements from heresay, to evaluating the material on various standards.

Some reading experts believe that it is more difficult to teach the higher levels of comprehension than the lower. Other believe there are different types, but that one is more difficult than any other.

These experts, therefore, also disagree as to the development of comprehension. Some believe it will develop as a general behavior, that once a person can master one type of comprehension, other comprehension skills will emerge. Other experts hold to the notion that each type of comprehension will develop singly, that since there are different levels, the development of one will not facilitate the emergence of another.

An initial problem for the researcher concerned with comprehension is to translate the types of skills recommended by experts into measurable responses exhibited by children. It is one thing to advance the notion that children should "develop their integrative processes" and another to identify items or questions for pupils to respond to that will indicate their ability in respect to that skill.

Once the types of comprehension are defined, and questions, or other methods, are developed so that the pupil's performance relating to comprehension can be measured, a series of interesting studies can be arranged. One would be to require pupils to read stories, then ask them several questions about the stories which represent many levels of comprehension. This type of status study would provide information about the relative difficulty of the levels of comprehension. Perhaps certain levels are more difficult for pupils to answer than others; perhaps there is little or no difference.

Other studies might then be concerned with acquisition and generalization. Children would be required to read material and answer questions on several levels. After a time, some form of instruction would be scheduled for only one level of comprehension. Data from such studies would reveal not only the direct effects of instruction on a specific level of comprehension, but the indirect effects as well, on the non-instructed levels of comprehension.

Spelling

Applied behavior analysts have not been too greatly concerned with spelling research; only a half dozen or so studies have been conducted in this area. The measures used in all those studies were the number or percentage of correctly and incorrectly spelled words. In some of the investigations the words were selected from the pupils' readers; in other studies the words were chosen from commercial spelling texts.

Although the studies are few, the interventions have been more diverse than in reading. Reinforcement contingencies, which included token systems, were used in some of the investigations. In other studies the intervention was a technique, sometimes referred to as look-cover and write-compare, where the pupils looked at the correctly spelled word, covered it, and wrote it, then compared their

word with the model. In one study the effects of peer tutoring on spelling accuracy was assessed; the peers used interventions of many types.

We have conducted several spelling investigations at the Curriculum Research Classroom. All of our measures have been the percentage of correctly and incorrectly spelled words. In several of the studies the words were arranged by part-word sounds. In one study,for example, they were grouped by the long e sound. Some words were spelled with the ee digraph, other with ea. We taught the ee rule first, then the ea rule. Our concern was to determine whether generalizations to other words that contained either ee or ea would emerge. After generalizations were established we presented words of both types to the children in order to determine whether they could discriminate between the two generalizations.

In another study we grouped words whose grapheme-phoneme relationships were highly predictable. We selected grapheme-phoneme elements that were, according to linguistic experts, very regular. For example, the /c/ sound is made by c over 80% of the time. Several words that contained c and made the /c/ sound were chosen. Words were selected so that the c was in final, medial, and initial position. After a baseline period, instruction focused on only a few of the words; we were again interested in generalization. We wanted to determine whether pupils would develop generalizations from the taught words to the untaught words when the untaught words contained letters and sounds similar to the taught words.

Although our findings in respect to spelling performance as a function of arranging words according to certain similarities have not been conclusive, I believe some more carefully conceived studies of this type might prove beneficial. A practical reason for encouraging research on various grouping stragegies is that all commercial spelling texts group words for instructional purposes on one basis or another. With one rare exception, the spelling method of Hanna, Hanna, and Hodges, the various grouping approaches have not been based on empirical evidence.

Some research should be conducted that focuses on grouping words by context, by frequency of usage, by using words in the pupils' vocabulary, by using words in the pupils' reader. Indeed, some interesting findings might emerge if words were grouped simply on the basis of word length. We did some preliminary research concerned with word length and found that long words are generally more difficult to spell than short words. Although it is doubtful that mere word length is the most influential variable in regard to learning to spell, length must certainly be considered.

Grouping words for instruction on the basis of some phonics generalizations should also be investigated. Perhaps one of the best ways to teach spelling would be to base a program on the data of Hanna, Hanna, and Hodges. Their studies provided probabilities for most phoneme-grapheme relationships. Research could be arranged wherein students were not only taught the various phonics rules, but also the probabilities associated with those rules. They could also be taught the peculiar letter arrangements that are associated with those probabilities. Armed with such an approach to spelling, the subject when asked to spell a word could sort through several alternatives before making a response.

The major learning topics of generalization and discrimination should be researched within the context of spelling. In reference to generalization and discrimination, it could be argued that pupils should be taught to spell by first learning a number of generalizations, then learning to discriminate amongst the generalizations. In one of our studies I described such an approach.

Other researchers might take a contrary or at least a modified approach to the matter of building generalizations and discriminations. They might advocate that pupils should first develop a few discriminations, then form generalizations, then more refined discriminations, and so forth.

Other spelling research should pertain to mode of response. Although writing is the most often used response mode for spelling, it may be that some people learn to spell best by speaking. I have been told that some years ago spelling bees were popular; pupils were required to spell words orally. I have also been told that people who were taught under such conditions became better spellers than those of today. Whether or not the two circumstances are directly related is an empirical matter. Therefore, some interesting research might be conducted wherein verbalization was the ultimate response or was used as a mediator.

Penmanship and Other Forms of "Writing"

There have been only a few Applied Behavior Analysis studies that dealt with penmanship. Some of the studies were concerned with printing, others with writing. In all of these studies the number of correct and incorrect letters was measured. The scoring of letters differed from one study to the next; some definitions were more rigorous than others. In every instance, however, reliability informatin was provided which indicated the investigators consistently discriminated a correct from an incorrect response.

In two of the studies I have examined, the intervention was a reinforcement contingency; the pupils were allowed free time contingent on the successful completion of their assignments. In one study, intermittent feedback was used. The interventions in two others were shaping and modeling. In the former, students were expected to construct more and more elements of the letters. In the latter study, they were asked to compare and evaluate their work with the letters of their teacher.

In none of these studies was the matter of proficiency considered. Although the researchers were concerned with changing the penmanship abilities of their clients, they did not take into account how much change they should effect so that the pupils would become proficient writers in terms of some outside criterion. In one study, for example, although the writing rates of the pupils doubled, as a function of the intervention, their rates were still half as fast as they should be according to some normative data we had gathered.

We have conducted, at the Curriculum Research Classroom, only a few penmanship studies. I will briefly describe two of these to indicate some of our measures and instructional techniques.

In one project we required the pupils to copy a short story from a sheet prepared in cursive or manuscript writing by the teacher. We counted the number of correct and incorrect "symbols" made by the pupils. A symbol was a letter, punctuation mark, or space between words. Following a baseline, a situation was arranged by which the pupils would be rewarded with free time, contingent on accurate completion of their work. Other interventions were used later, such as drill on wrong letters and copying directly beneath each line on the model sheet.

During another project our concern was only with cursive writing. Regardless of the background and ability of our students they began with cursive writing. In the beginning of the project they wrote all the lower and upper case letters and several words that contained many connective forms. After a few days we arranged an intervention for lower case letters. The intervention was "selective" checking. The teacher selected a few letters that would be checked each day, unknown in advance to the pupil. If the pupil erred on one of those letters, he had to practice writing it correctly several times. After proficiency (three consecutive 100% days) was reached on lower case letters, the intervention was shifted to the upper case letters, then finally to words.

In both these writing projects performance criteria were established. In the first, correct and error rate criteria were used, whereas in the second, a correct percentage criterion was established.

Before any more research should be encouraged in respect to penmanship, some study should go into a survey of the uses of handwriting. Several years ago, before typewriters, dictaphones, cassette tape recorders, and methods for speedwriting, handwriting were more useful than it is at present. Today, many types of communication can be more efficiently handled by means other than writing. The composition of letters, stories, reports is much more efficiently accomplished if a typewriter is used. When speed and legibility are considered, writing is no match for typing. If very quick communication is desired, a dictaphone or cassette tape can be used. If note-taking is the objective individuals can be taught some method of speedwriting. In summary, knowing how to write legibly is not now as important a skill as it once was.

There are instances, however, where writing is necessary. People are required to use manuscript writing when they fill out forms. They use manuscript or cursive writing to compose notes and memos for themselves and others.

Once the occasions are specified in which either manuscript or cursive writing are required, then researchers should strive to develop the quickest way possible for teaching the various forms. Teachers and researchers should spend no more time than necessary, however, in the instruction of penmanship.

Communication research should beging to focus on other means for preserving and transferring information. Research is desperately needed on how best to teach children to type. In a project we ran last year we had moderate success in teaching youngsters to use typewriters.

Research should be encouraged on how best to teach individuals to use a dictaphone. This is by far the fastest means of transferring messages. For example, my handwriting rate is about 15 words per minute, my typing rate about 50, and my dictation rate about 150 words per minute. It would appear that if researchers could identify the necessary steps to teach dictating, the learners would be about three times more efficient than if they typed and ten times more efficient than if they wrote when it comes to transferring their thoughts.

Research should also be concerned with speedwriting and note-taking. If researchers were able to identify the important skills for taking notes and for teaching speedwriting, more students enrolled in lecture classes would be able to handle the work of the course.

Composition

Applied behavior analysts have conducted very few studies pertaining to composition. In fact, I have found only one study that was a research investigation in the sense that a variable was manipulated. In that study the daily measures were total number of words, different words, new words, and time spent writing. Following the study the writings of the pupils were rated on a scale that took into account certain mechanical aspects, vocabulary complexity, number of ideas, development of the ideas, and internal consistency of the stories. In that study, points were first contingently scheduled for number of words, then for different words, and finally for new words.

At the Curriculum Research Classroom we have conducted several composition studies. In most of the investigations we measured several mechanical aspects of writing on a daily basis. Some of these were number and rate of correct and incorrect uses of punctuation, correctly and incorrectly spelled words, correct and incorrect uses of capitals, and correctly and incorrectly formed letters. We have also obtained several measures that pertained to content. Some of those were number of words, sentences, number of adjectives, and number of new words. We have also measured other more complex features of content, such as number of ideas, integration of material, and overall creativity of the stories. For the latter three measures we employed standardized scales.

We have investigated the writing of pupils as influenced by a variety of techniques. These were techniques often used by teachers to stimulate writing. In some instances the pupils were shown pictures before they wrote, in others they were given a story title, in still other a lead sentence. On other occasions the pupils selected their own topics, and in some instances a story was read to them.

Several interventions have been scheduled in efforts to alter certain aspects of writing. One of these was simply to tell pupils what to change, e.g., "write more legibly." Another intervention was to provide instruction for specific skills, e.g., for the correct use of capitals and punctuation marks. During some studies we gave verbal praise contingent on attending to certain mechanical features, and for other students we provided written feedback in reference to some aspects of content.

Research in the area of written composition, although extremely difficult to conceptualize, might well be more important than investigations in other curricular areas. The reason for such a statement is that writing requires competencies in most of the basic skill areas. In order to write, the pupil must be able to form letters legibly and to spell reasonably well. He must know certain grammatical rules—that sentences contain subjects and verbs, and often nouns are modified by adjectives. In order to write, the pupil must understand the rules concerning capitalization and punctuation. If the person is to write logical narration he must know that one sentence should lead to the next, and that all the sentences in a paragraph should be related to the same topic.

One of the researchers' first tasks should be to classify the types of writing that pupils should develop. Should they be taught to write diaries, personal memos, business letters, short stories, poetry? The probability of training more writers will be increased if they are taught to write for specific purposes. Often, in our schools, writing is not systematically taught. One day the pupils are asked to write biographies, the next science fiction stories, and the next, Haiku poetry.

The researchers' next task in setting up writing studies is to identify the important elements for each type of writing. The researcher must identify enough elements to depict accurately each type of writing. He should not pinpoint too many, however, for each selected behavior should be measured daily. The researcher may well receive more information than he is able to process.

If research is being conducted in diary writing, perhaps the most important measures would be number of accurate recollections, or novel ideals. For this type of writing it would seem irrelevant to measure the total number of words, the number of different words, or correct uses of punctuation and capitals.

If research were being conducted on how to write business letters, another set of measures would probably be appropriate. Since the appearance as well as the content of the letter would be important, it is likely that measures of legibility, punctuation, capitalization, organization, and clarity should be obtained.

In order to conduct research on fictional writing, other compositional elements should be measured. Apart from measuring students' abilities in regard to the mechanics of writing and behaviors pertaining to grammatical usage and the handling of dialogue, researchers must identify how to foster self-evaluation. If writers are to be developed they must be taught to criticize their own work, then re-write, criticize again, and re-write. Most people are totally incapable of re-writing. When asked to re-do a manuscript, they simply correct the spelling or change some of the punctuation. Researchers should define the steps writers must follow in order to re-write and refine their work.

Another purpose for teaching writing actually transcends the notions of writing as a form of communication or writing as an art form. It is that often when people write, their thinking is influenced. The act of writing sometimes assists in the organization of their thoughts and stimulates partially formed explanations or arguments into fuller expression.

If the researcher is concerned with writing as it affects thinking, one of the most important measures would relate to logic or continuity. It would be important to develop the skill of moving clearly from one point to the next. For this type of writing, the use of new or different words, complete sentences, and the number of words would probably not be important measures.

In order to conduct research in writing, of whatever type, multiple measures are required. In many instances various measures in regard to mechanics will be desired, in addition to several content measures. Many hours of an investigator's time could be devoted to obtaining these data, graphing, and analyzing them. In order to acquire multiple bits of data a small computer system should be used that will free the investigator from the arduous tasks of scoring, counting, and graphing. She could better use her time analyzing each measure and looking for relationships. After several studies had been conducted from which multiple measures were obtained, and after all the data from those studies had been thoroughly digested and synthesized, researchers would then be able to decide which behaviors should be measured and which ones should not. They would then list the measures in terms of priority, determining, for example, which three behaviors should be measured if the teacher has time to measure only three.

Arithmetic

In relation to other academic areas, applied behavior analysts have conducted a substantial number of arithmetic studies, concerned with a wide variety of arithmetic skills. Some have dealt with counting, reversing digits, addition, subtraction, division, multiplication, and story problems. As was true in other academic areas, the primary intervention was the use of some reinforcement contingency. Praise was used in several of the studies and token systems in others. Other interventions included drill and feedback of various types. In one study, peers were used to influence performance.

The manner in which the different math skills were measured varied considerably. In many studies percentage of correct answers was the measure. In one, pre- and post-tests were used, whereas in a few, the frequency of correct answers was recorded. In one study rate of correct answers per minute was the basic data.

In most of the studies the types of problems assigned to pupils were vaguely described. Following are some of the descriptions: "the pupils were assigned addition problems from Addison Wesley," "they worked on addition problems," or "the students were assigned story problems." In other studies the problems were adequately defined, but they were of many types. In one study the pupils were assigned several types of multiplication problems ranging from the basic facts to problems with several numerals. In only one study that I have seen did the authors carefully describe the type of problems and use a single type of problem. That investigation was concerned with reversing numerals.

That the type of problem has been so ill-defined is somewhat of a paradox in that the accurate description of procedures and materials is one of the basic tenents of Applied Behavior Analysis. This is also peculiar since it is a rather simple matter to define arithmetic computation problems.

At the Curriculum Research Classroom we have conducted many arithmetic studies. These have dealt with several types of addition, subtraction, multiplication, and division problems, and with story problems. In all the studies, the types of problems have been carefully defined, e.g., two addend addition problems where both addends contained numerals between 22 and 66 and where no carrying was involved. We have used two measures to report the data from these studies, correct percentage and rate per minute. In all our studies where rate was the measure, two rates were simultaneously used, correct and incorrect problems answered per minute.

We have investigated the effects of many interventions, among them several types of reinforcement contingencies. In some studies token systems were arranged: point were either given or taken away. The points were redeemable for leisure time, recess, or models. In most of our studies, however, interventions other than reinforcement contingencies were used. We have studied various types of feedback: telling pupils which problems were correct, which ones were incorrect, telling them which ones were incorrect, telling them which ones correct and incorrect, telling pupils what their rates were, what their rates were relevant to yesterday's, relevant to their teacher's rate, relevant to a peer's, relevent to their desired rate.

We have studied various types of modeling: showing pupils how to solve problems, and leaving a sample problem for them to check. We have simply told pupils what to do, e.g., "be more careful" or "work faster." We have written out and placed on pupil's paper the steps for solving problems. We have arranged many studies to assess the influence of teaching aids such as the abacus, numberline, paper clips, quisinare rods, and other manipulatable objects. In other studies we have investigated the effects of drill when scheduled before and after the arithmetic assignment. The effects of small digital computers have been assessed when arranged before and after the arithmetic assignment. In some studies pupils have been asked to verbalize the problem and answer before writing the answer.

We have also conducted a few studies dealing with story problems. In these, our primary effort was to identify types of story problems. Following the definition of several types of problems we investigated the influence on performance of several interventions.

In our math research, in addition to specifying the problem types rather carefully, we have classified the abilities of students to perform these problems. In several investigations we have used a system wherein the students are classified at one of two performance levels: acquisition proficiency. An acquisition situation was one in which the pupil could not compute problems of a certain type and yet had demonstrated the necessary prerequisites. By definition, a pupil's percentage score during the baseline period of an acquisition situation would be zero.

Proficiency situations were those in which the pupil was able to compute problems of a certain type with near-perfect accuracy, but he did so slowly. His rates would be much slower than those of his peers.

In a few studies we used a three-level classification system: initial acquisition, advanced acquisition, and initial proficiency. Initial acquisition and initial proficiency were those situations previously described as acquisition and proficiency. Advanced acquisition were those situations where the pupil responded to a certain set of problems with 40-60% accuracy he could answer about half the problems correctly and half would be incorrect.

Researchers should strive to identify other performance levels. They could classify arithmetic performance into two, three, or more performance levels. The levels, such as initial acquisition, could be

further subdivided by process, e.g., addition or subtraction. They could next list all the possible interventions that could influence performance: interventions such as modeling and feedback. The types of interventions could also be subdivided since there are several modifications of each intervention. There are, for instance, several forms of feedback, many of them have been referred to in this paper. From the matrix, researchers could proceed to obtain information which corresponds to levels and techniques. We have conducted several studies, the information from which pertains to several entries on the matrix. For instance, we have investigated the effects of several types of feedback on three levels of performance. We have studied the influence of three types of modeling on two performance levels, the effects of positive reinforcement on two levels, withdrawal of positive reinforcement on one, and several types of prompting on one performance level.

	Initial Acquisition				Advanced Acquisition				Initial Proficiency			
	A	S	M	D	A	S	M	D	A	S	M	D
Modeling												
Feedback												
Pos. Reinforcement												
With. of Pos. Rein.												
Prompting												
Punishment												

Once a substantial amount of data were derived from all the techniques across the various levels, some important relationships would probably become evident. For example, it might be revealed that some techniques are effective across all performance levels: initial acquisition, advanced acquisition, initial proficiency. It might be learned that some techniques are effective with problems of only a certain level. It might be revealed that some techniques are effective across performance levels for only certain processes, e.g., addition or subtraction.

The implications of such a systematic exploration for teachers are tremendous; for teachers would be given sound advice about which technique should be scheduled first to teach any type of problem. A system such as this would greatly reduce the possibility of selecting inappropriate interventions. Consequently, the probability of helping more pupils to become better mathematicians is vastly increased.

Once researchers have compiled these data regarding the effects of single techniques such as modeling or feedback on various processes and levels of performance, they can combine certain techniques in the effort to determine whether these are cumulative effects. It might well be revealed that certain types of problems at certain performance levels are learned most rapidly if a type of modeling is used along with a feedback variant. It might be determined that the mastery of some subtraction problems at certain levels is significantly aided if a prompting technique is used, along with a form of reinforcement.

Our research has always dealt with a single problem type. The pupils were required to respond to problems of one kind, e.g., simple addend addition where the sums were less than 15. Research might be arranged wherein problems of various types are assigned. Some mathematics experts have recommended that the family approach should be used to teach addition and subtraction. That is, problems like 6 + = [ ] and 13 - 16 =6 = [ ] should be assigned. No research of any methodology is available to lend support to the notion that this is a good or better way to teach addition and subtraction. Researchers should explore the efficacy of teaching other groupings, such as addition with multiplication, subtraction along with division, or division and multiplication.

Other research might focus on the instruction of format variants of the same problems. For example, situations should be studied where vertical and horizontally formed problems are simultaneously taught (4 and 4 + 2 = [ ]). Studies should be arranged to study performance gains when various algebraic arrangements are simultaneously taught, e.g., 4 + 2 + [ ]; 4 + [ ] = 6; [ ] + 2 = 6.

Within the context of arithmetic computation, studies concerned with generalization and discrimination should be arranged. We have conducted many studies to assess generalizations from one type of problem to another. Our approach has been to schedule problems of two or three types for the pupil. Following a baseline period an intervention would be focused on one type. This process was explained in more detail earlier in the paper. With such a technique we can observe not only the direct, but the indirect effects of teaching. Researchers should extend this plan by requiring pupils to work on problems of many types.

Studies should also be arranged to study discrimination. Situations might be scheduled wherein pupils are required to answer a collection of problems of various types and levels. Quite possibly, some pupils can become very proficient with one class of problems at a time, but when the problems are presented together, they are unable to discriminate among the various types and as a result commit many errors. It might be that different interventions are required to teach discriminations than the ones mentioned here. In fact, it may be disclosed that a unique set of interventions is more suitable for teaching generalizations and yet another set is required to teach discriminations.

Pupil-Management

Recently, a few applied behavior analysts have conducted experiments in which the effects of various aspects of pupil-management were investigated. These studies generally selected one element of the teaching process, e.g., counting responses or specifying contingencies, and compared the effects on some academic task when the teacher managed the situation and when it was administered by the pupil. One study, for example, compared the arithmetic achievement of pupils during conditions under which the teacher specified the contingencies with their performance when the pupils arranged their own contingencies.

We have conducted several projects concerned with various pupil-management behaviors, among them, pupil-counting, - graphing, - correcting, - scheduling, - arranging contingencies, and -selecting instructional techniques. The majority of our studies were like those of other applied behavior analysts, in that pupil performance was compared throughout two conditions—one under which the teacher administered the key component and one under which that component was administered by the pupil.

Additional investigations should continue with this type of research with the purpose of ascertaining the reinforcing strength of various pupil-management components. The significance of this type of research is that if it is determined that some pupils are reinforced by certain aspects of teaching, then another category of motivators will be available for teachers to use. The general motivational groups that teachers can now use are praise, tangibles, free time, and miscellaneous classroom activities. In order to instruct certain children the biggest problem for some teachers is to discover a reinforcer; therefore, the addition of another class of reinforcers would be a significant contribution.

Future researchers should select teaching components other than those previously considered, and conduct experiments wherein they are alternately administered by the teacher and the pupil. One component of possible interest is the determination of the task to be learned. A situation might be established where some pupils decided what should be learned. For other pupils the teacher could specify what should be learned. For other pupils the teacher could specify what should be learned. Comparisons might then be made between the two groups as to rate of progress. Other components of the teaching process that could be similarly investigated would be the establishment of a performance aim, the length of a study period, the type of data display, the determination of the person to whom progress should be reported, and the method of reporting progress. In all of these instances the teacher and pupil could alternately perform the duty.

With children who are motivated by self-direction, ways should be found to give them more opportunities for self-governance. They should be allowed to select what they want to learn, choose their own method for instruction, chart their own progress, evaluate their gains, criticize their performance, and reward themselves.

Meanwhile, for the pupil who is not motivated by self-management activities, attention should first be directed toward increasing the probability that various self-management activities would, in the future, be reinforcing. One often-used strategy for building reinforcers is to pair a non-reinforcing event with a reinforcing event, then gradually fade the reinforcing event so that the previously non-reinforcing event assumes reinforcing qualities. Several intriguing research studies could be arranged to evaluate various pairing and fading approaches.

Establishing whether various instructional components are reinforcing is only one pupil-management strategy. Another reason for directing research attention toward pupil-management is to determine the best methods for training pupils to gather data. This rather utilitarian purpose for investigating pupil-management was discussed earlier, in the section on logistics. Obviously, if pupils can be taught to assist in the data gathering process, their teachers can obtain more data bout the progress of their pupils than if no help is available.

Apart from these two reasons for conducting research concerning pupil management, the primary concern for this topic is to assist pupils to develop as self-disciplined and independent citizens. Although school teachers and parents state that one of their major educational aims is to teach children to become independent citizens, little formal effort is actually directed toward this goal. Apparently children are expected to emerge naturally as independent and self-directed individuals.

Certainly some pupils do become self-directed adults. They are able to be creative and productive throughout many years of their lives; they can cope with the many irritations and disappointments of life; they can adapt and yet maintain their own sense of integrity; they can influence others for the betterment of all. Indeed, there are some creative, self-directed individuals, but for every one of this caliber there are millions who are not. We need but look around us to find dozens of people who are torn and worn physically and mentally. They are filled with self-pity, doubt, and remorse. Many of them believe change is not possible. Some would like to change but cannot; they are not equipped for modification.

John Gardner, in his book *Self-Renewal*, makes a strong case for acquiring self-directing skills. He claims that people have many skills, and their usefulness is changing in reference to the individual and his society, are static. He further posits that in order for individuals to develop and thrive, they must be in a constant state of self-renewal.

I concur, and would add that in order for individuals to develop, they must possess the behaviors necessary for development. People must know what steps to take in order to change themselves. It is not enough simply to want to change; an individual must be able to analyze what he is currently doing that pleases him and assists others; he must be able to identify the circumstances that are controlling these behaviors. He must be able to pinpoint those events that irritate him and the circumstances that are bringing on those events. He must be able to rearrange his life to decrease the irritants and increase the pleasures so that he may then assist himself and others. He must be able to evaluate his life continuously (once a year at New Year's is not enough) and be able to make the necessary adjustments in order that he and those he is trying to teach independence (not those dependent on him) can enjoy a consistently rich and productive life.

In the elementary and secondary schools, self-management instruction should be provided and given as much curricular status as reading and arithmetic. Teachers should be required to be competent instructors of pupil-management, as well as skilled teachers of reading and arithmetic. This is not to say that a definite period of time should be scheduled each day for the teaching of pupil-management or reading, for that type of rigid scheduling might not prove to be the best method of getting the desired result. I simply mean that self-management, like other important skills, should be systematically taught. The development of self-management should not be left up to the capriciousness of Mother Nature.

Researchers must identify the behaviors that comprise self-management and arrange a sequence of those behaviors. They must discover the best ways to teach self-management. They must also discover what environmental circumstances maintain those behaviors. Finally, they must disseminate all this information to teachers.

METHODOLOGICAL LIMITATIONS AND RECOMMENDATIONS

Throughout this paper I have recommended the use of the Applied Behavior Analysis research methodology. I believe this to be the best methodology for studying the problems of human development, including curricular matters for learning disabled children. There are, however, some limitations to this system. Many of those limitations offer opportunities for researchers concerned with methodological issues.

One limitation has to do with making educational decisions based on data. This limitation is shared by other research systems. Although some recent work has been directed toward this issue, a certain amount of research should be concerned with such matters as how long to run a baseline and when to begin teaching, and when to abandon one teaching technique in favor of another. There is a need for simple and effective means for analyzing data in order that we may become fully informed about these matters.

A second limitation of this system has been brought about by one of the prime features of Applied Behavior Analysis—the matter of setting up a stable and consistent environment when arranging a study. The researcher is urged to define all environmental events that can possibly influence behavior and hold them constant throughout a baseline period. Following the baseline, one variable would be changed in order to determine its relationship with the measured behavior.

One important variable that is held constant each session is time. It is generally recommended that experimental sessions be held for the same amount of time and at the same time each day. This idea of being consistent as to time is not incompatible with the schedules of public schools. In some schools the reading period begins at 10:00 every day and lasts for 45 minutes; the arithmetic period begins at 11:00 and runs for 50 minutes.

The obvious reason for holding many events constant and manipulating only one at a time is to discover which one influenced the measured behavior. If variables are capriciously maneuvered and change results, the investigator will not know to what he should attribute the change.

Not only does consistency lead to good science, I cannot help believing that a fair amount of consistency is required for good teaching. It is very possible that some children who are experiencing academic failure and are referred to as learning disabled are having problems because their programs lacked consistency. One day they were taught with one remediation approach; on another day a totally different technique was used.

But notwithstanding the fact that consistency as to time and other variables is good for research and teaching, I am not at all times concerned about holding time rigidly constant. I believe it is possible that on some days a child may want to read most of the day and not do much math, and that on other days he might prefer to do just the opposite. Although I believe that some skills will not develop as well as they might unless some time is devoted to them every day, it would be interesting if researchers would arrange studies to investigate the issue of fixed and flexible sessions. Reading performance, for example, might be measured during periods when the time was constant and again when it was flexible. The notion of being somewhat flexible with time factors is consistent with my previous remarks about pupil-management, certainly with the aspect of scheduling.

The programming rigidity of Applied Behavior Analysis may sometimes lead to another limitation, that of situational generalization. Teachers have often lamented that some pupils write legibly during penmanship period, but not when they write their answers to arithmetic or reading questions. Other children spell accurately during spelling period, but not at other times. The manner in which periods are set up to conduct research studies or teach specific subjects may seem to work counter to the notion of generalization. Perhaps researchers should arrange situations whereby several behaviors are simultaneously emphasized, or wherein data in regard to secondary skills are at least intermittently obtained. As to the former suggestion, perhaps language arts studies might be devised in which measures were obtained in regard to reading, writing, and spelling. Interventions might be devised to influence all three components. As to the latter suggestion, an example would be to measure a pupil's handwriting performance occasionally during the spelling period.

A fourth limitation of the Applied Bheavior Analysis system is also a function of the one-subject-at-a-time approach to research. This limitation has to do with the interrelationships of behaviors. Currently, applied behavior analysts who conduct curricular research analyze the data from one behavior at a time. They look at the reading data, then the arithmetic data, then the penmanship data. Of course there are some who study the "whole child," by analyzing all the data for a particular child, but these efforts are often rather casual.

A fruitful research area for investigators would be to monitor many academic and social behaviors and study the complex relationships amongst them. A single variable within the total program would then be altered and the researchers would analyze the direct and possible indirect effects of the alteration. It is quite conceivable that when an intervention is associated with a child's reading, and his reading improves, that improvement is generalized to social studies, arithmetic, perhaps even to soccer playing.

RESEARCH STRATEGY RECOMMENDATIONS

Finally, I would like to suggest two major changes in the way curriculum research has been traditionally managed. I believe both of these alterations would, to a great extent, alleviate the long-standing criticism that little academic research has been implemented in schools, and when it has been, the latency between discovery and implementation was great.

The first recommendation relates to the location of research. Currently, most educational research is conducted at universities. The major part of my research, forexample, has been conducted at the University of Washington. Although we have tried to be responsive to the needs of teachers by studying problems of importance to them, and have attempted to disseminate our findings to teachers, those efforts have not been systematic. No plan has been followed to discover what schools thought should be studied, to disseminate research findiggs to them, or to learn which of our findings they did implement. I, therefore, suggest that curriculum research classrooms be established in some public school settings.

The research classroom in a public school could investigate the problems and concerns of that school: how best to teach penmanship, reading, civics, or any other subject important to that school. Conceivably, if the research classroom is investigating problems indigenous to a particular school, *at* that school, the results of that research should be readily incorporated into that school's operation.

Some research today, because it is conducted in places other than public schools, is directed toward matters that are of no current concern to teachers. Some investigators base their studies on problems they were familiar with when they attended school many years ago. Therefore, some of their research, although elegantly designed, is not highly relevant to today's concerns.

I would not recommend that all educational research be shifted to the public schools, any more than agronomists would suggest transferring all their research and development to private farms. The research efforts at universities should be concerned with new information; they should develop new techniques and teaching strategies. The research classroom in the schools should be responsive to current demands.

An important part of such an arrangement would be a close cooperativeness between the two locations. Several public school research classrooms might be associated with a university research location. Information could be shared across these settings. Perhaps the researchers could be trained at the university setting, then shifted to the public schools. Several such interrelationships could be established that would contribute to a rapprochement between the public schools and the universities.

The second recommendation is in reference to the entrepreneurship of curriculum researchers. Today, only a few people are committed to curriculum research, and perhaps for that reason some of these are attempting to do it all. I recently visited a curriculum research unit at a major university. The following were the objectives of their research: a) to identify all the important elements of reading, arithmetic, and social development; b) to identify all the interventions that can be used to alter the various reading, arithmetic, and social behaviors; and c) to establish a computer system whereby teachers could phone in and obtain the most appropriate intervention for a specific behavior. Such an awesome

task! We are just about as presumptuous at our little Curriculum Research Classroom at the Experimental Education Unit. We are attempting to evaluate a great many of the interventions that are commonly associated with several basic skills.

Undoubtedly there will be some contributions from such research organizations, but at best the information will be scattered. Some will relate to certain aspects of reading, some to various aspects of arithmetic. It is doubtful, however, that the research from such locales will thoroughly explore any specific curricular area.

I would, therefore, recommend that research confederations be established, all using the same basic research methodology. Several applied behavior analysts should form a group and collectively set out to investigate curricular matters. Some researchers could specialize in reading, some in math, others in spelling, some with logistical matters. The subdivisions could be further refined; some could focus on initial reading, others on encoding. Some could investigate various reinforcers and how they affect various reading behaviors, other could investigate the effects of variables other than reinforcers.

These researchers would not have to be located in the same place; some could be in North Dakota, others in Rhode Island, and still others in California. Such a system would allow and encourage each research organization to investigate thoroughly a small part of the curriculum package. Such thoroughness would enable those researchers to recommend to teachers, with greater conviction than they can now summon, what they should teach and how best it should be taught.

The two recommendations I have made are compatible with one another. At the university level, each research organization would focus on a specific curricular area. Across the country, each area would be covered. At the public school level, each research classroom would be concerned with problems peculiar to their own schools. Some of the schools would be in the suburbs, some in central areas; schools of all types would be represented. Communication would flow not only between the public school satellites and their university sponsor, but from university to university, and from public school to public school.

SOCIO-CULTURAL CORRELATES OF LEARNING AND BEHAVIOR "PROBLEMS"

Jane R. Mercer

My assignment for this conference is to discuss fundamental issues in research on sociocultural correlates of learning and behavior problems in children and to suggest various lines of basic research which might prove to be productive if pursued as part of a systematic research agenda by the National Institute of Education. The first portion of this paper will focus on certain conceptual problems relating to the types of theoretical models typically used by persons doing research in this area and their relevance to research in sociocultural correlates of behavior. The second portion of this paper will utilize some preliminary findings from two studies of elementary school children which we have been conducting in the State of California as the basis for discussing some specific questions which need further investigation from the various perspectives.

Fundamental Conceptual Issues

It is essential that those persons planning the research agenda for the study of "learning disabilities and behavior problems" in children and those persons conducting the research make explicit the theoretical model from which they are operating in any particular investigation. The investigator's conceptual framework not only determines the types of research questions which will be asked and the manner in which the research will be designed but also determines how the dependent variables "learning disabilities and behavior problems" will be defined and operationalized. Because the conceptual model used by the investigator is of such central importance, the choice of a framework for a particular study or set of studies should be a deliberate process in which the assumptions of each model are reviewed and their efficacy weighed. The perspective should be explicit rather than implicit.

Each of the basic models is useful for certain purposes. Each creates a different construction of reality, a different mapping of the empirical world. Consequently, findings and insights gained from research conducted from differing perspectives will vary. However, it is this variety which should be encouraged in a systematic research effort rather than exclusive concentration on more familiar, traditional models. This variety is particularly critical in research dealing with sociocultural correlates of behavior. A balanced research portfolio should include projects which look at the same phenomena from different perspectives.

After briefly describing the characteristics and assumptions of three different conceptual models, I will examine the manner in which each model influences research on sociocultural correlates of behavior.

The Pathological Model

The pathological model was developed in medicine as a conceptual tool for comprehending disease processes and organic malfunctioning. Because diseases are defined by the biological symptoms which characterize them, the focus of the model is on pathological processes and their symptoms. A pathological process is identified by the fact that it tends to destroy the biological integrity of the organism as a living system. Emphasis is on defining the nature of the abnormal, and normal tends to be treated as a residual category containing organisms that do not have symptoms of pathology. Because homo sapiens are very similar biologically, biological processes operating in one member of the species are similar to those operating in other members of the species and findings from research can be generalized with a high level of validity to other members of the species even though they have been socialized in different cultural milieux. Thus, the pathological model, *when used to describe biological processes*, is a universal model which transcends social system boundaries.

Conceptually, the pathological model is bi-polar. At one pole is "normal" which is equated with health, the absence of pathological symptoms. At the other pole is "pathological", defined by the presence of pathological signs or symptoms. "Normal" tends to be a residual undefined category in the

sense that "normal" persons are those who do *not* have symptoms. Persons are ranged along the continuum from normal to pathological based on an implicit value consensus that having pathological signs is a "bad" situation. Clinician, investigator, and research subject can usually agree that it is better to live than to die, better to be free of biological symptoms than to have them. Therefore, they usually do not need to work through differing definitions of the situation and can cooperate to investigate the etiology of signs which they all agree are undesirable.

Although the pathological model was first developed in the field of medicine and has been a very powerful conceptual tool in comprehending many of the biological ills which beset mankind, it has also been used extensively in attempting to conceptualize phenomena which are essentially behavioral, such as "learning disabilities" and "behavior problems", the topics of this conference. The decision to use a pathological model to conceptualize research projects dealing with differences in behavior has several important consequences.

First, there is likely to be a decided emphasis on identifying the characteristics of behavior which are regarded as abnormal with a tendency to neglect examination of the "normal", more positive aspects of behavior. The subjects of the research effort tend to be described in terms of the pathological symptoms which they manifest. Thus, the pathological model is essentially a deficit model describing persons in terms of what is "wrong" with them. Their strengths tend to receive less attention because they are frequently treated as an undefined, residual category. This bias toward explicating the pathological is clearly seen in the very terms in which this conference has been convened. We are here to discuss learning *disabilities* and behavior *problems*. Suppose the organizers of this conference had attempted to focus on the positive end of the continuum. They might have called a conference to discuss research on "learning abilities and behavior non-problems". Our professional vocabulary is so infused with the biases of the pathological model that we do not have nouns or adjectives which are adequate to describe non-problem behavior.

Second, the pathological model focuses specifically on the individual being studied because a disease process is a characteristic of the biological organism. When using a pathological model to describe behavior, investigators tend to see the behavior as an attribute of the person, a symptom which *he* has. Consequently, the focus of both research and intervention is on changing the behavior of the individual person so that it will be free of the symptoms of pathology. The burden of change is on the individual. The pathology is perceived as residing *in* the person. The sociocultural setting in which the behavior takes place tends to be treated as an extraneous factor.

Third, the medical perspective operates in terms of the logic of cause and effect reasoning. If a person manifests signs interpreted as symptomatic of pathology, etiological questions are immediately raised. What condtions in the biological organism have caused these symptoms?

Fourth, when using a pathological model to understand behavior, investigators tend to think in terms of etiological hypotheses which trace causal chains back to the biological organism. There is a strong bias in favor of exploring physiological and genetic hypotheses. Social and cultural factors which may be related to etiology tend to be discounted, unless it can be demonstrated that such factors have produced organic damage which, in turn, has produced the symptoms of pathology. Biological malfunctioning is often posited even if it cannot be clearly demonstrated. Those wedded to the pathological model in the study of behavior disorders frequently postulate the presence of "minimal brain damage" even though such damage has not been conclusively established.

Fifth, when using the pathological model to study behavior, researchers are prone to assume that a value consensus exists about the kinds of behavior which are pathological in the same sense that there is a value consensus concerning what constitutes the symptoms of a disease. They assume that those behaviors which they, as researchers and scientists, regard as "problems" are universally regarded as "problems". In so doing, they raise to the level of scientific universals canons of behavior which may be culture-specific. This simplifying assumption *may* be necessary for the conduct of certain types of investigations but should be made knowingly after alternative assumptions have been explored. A universal value consensus cannot be assumed in all cases and the issue should be explicitly addressed in the design of any research project dealing with behavioral manifestations and/or sociocultural correlates of behavior.

Sixth, from a medical perspective, a pathological condition can exist in an individual even though no one in his circle of significant others is aware of its presence. Such a position makes considerable sense when we are dealing with disease processes such as tuberculosis or rheumatic fever, but becomes problematic when we are dealing with behavior problems. "Problems" may be specific to particular social systems and the norms of those systems. Behavior which constitutes a "problem" in one social system may not constitute a "problem" in another social system. Can a behavior problem exist, undiagnosed and unrecognized by others in the social group?

Finally, and closely related to the above, those who use the pathological model tend to think in universal, suprasocietal terms. In general, the biological organism of the human species responds in similar fashion to physical trauma and disease processes regardless of its cultural milieu. Biological findings are applicable across cultural boundaries and biological concepts and technology may transcend social systems. Cross-cultural comparisons are accepted as valid using the same measurement techniques and the same definitions of symptomotology. However, only in certain limited situations can studies of behavior be treated as having universal application beyond the social system in which the study was conducted.

In view of the assumptions and limitations of the pathological model, it is my opinion that a pathological model is the preferred perspective for doing research in sociocultural correlates of learning disabilities and behavior problems when:

1. There is reason to hypothesize that certain sociocultural factors are producing measurable changes in the biological organism of the child, and,
2. That these changes in the biological organism of the child are producing specific behavioral manifestations which,
3. are regarded as disabilities or problems in most sociocultural groups.

If these conditions are not met, some other conceptual framework is generally to be preferred.

The Statistical Model

The statistical definition of "normal" is familiar to anyone who has taken an elementary course in statistics and been introduced to the concept of the normal curve. Unlike the pathological model which defines the symptoms of pathology in relationship to some types of biological, functional analysis, the statistical model defines abnormality in terms of an individual's position on an assumed normal distribution relative to those in the population being studied. Establishing the statistically normal is a straightforward process. The investigator specifies the population of persons on which the norms will be based and then measures a sample of that population. Scores on the measure are organized into a frequency distribution and the average score, the statistical mean, is accepted as the norm. Customarily, persons with scores which deviate not more than one standard deviation above or below the mean are regarded as falling in the "normal range", approximately 68% of the population. A "normal" established in this fashion does not necessarily imply "healthy" or "good". To be statistically normal has no implicit value assumption because the measurements can concern matters of indifference to the social world. However, when the statistical model is used to describe socially valued or de-valued characteristics, assessments may acquire a judgmental quality depending upon the social values associated with the characteristic being studied.

Unlike the bipolar pathological model, the statistical model defines the boundaries of *two types* of abnormality; those who have abnormally large "scores" for the characteristic in question and those who have abnormally small 'scores". The statistical model as an abstract construct does not necessarily imply an evaluative judgment on the part of the investigator. The statistical model may be used to describe biological processes and to establish norms for biological characteristics but, unlike the pathological model, it is not limited to the description of biological characteristics and behavioral manifestations based on biological characteristics. It may be used to assess behavioral manifestations which are not directly linked to measurable biologic anomalies. The decision to use a statistical model in the study of sociocultural correlates of learning disability and behavior problems is based on certain assumptions and has important implications for the research effort.

First, when the statistical model is used in close conjunction with the pathological model, there is a tendency to think in terms of one model while operating with the other. Behavior which has been defined as a "problem" by the scientific community—such as a low score on the WISC or "soft signs" on The Bender—become conceptually transposed into pathological signs carrying all the implications of the pathological perspective but without any evidence based on functional analysis that these pathological signs are related to the biology of the organism.

Second, when a statistical model is used to define normal behavior, the norms emerging from measurements taken on one population cannot be safely generalized beyond that population until it is clearly established that the two populations are socioculturally similar. If the statistical probabilities are less than 5 in 100 that the populations are the "same", then the investigator must treat the populations as distinct. The applicability of the statistical model in the study of sociocultural correlates of behavior must be rigorously circumscribed when two or more populations which are statistically different are being studied.

Third, the statistical model assumes that the distribution of a characteristic in the population being measured is normal. If, instead, the characteristic is not normally distributed, a statistically defined normal is a misleading indicator. Should the distribution be skewed, the mean will move in the direction of the skew. Even more serious, if the distribution is biomodal and this factor is overlooked and the distribution is treated as unimodal, the investigator may be treating two statistically different populations as if they were the same population. This assumption of the statistical model becomes particularly important in the study of sociocultural correlates of behavior in a multicultural society. Normal distributions cannot be assumed but must be demonstrated before a standard statistical model is applied in the study of behavioral differences in socioculturally complex populations.

Fourth, unlike the pathological model, when the statistical model is applied to any population in which there is any variability it will always identify some persons as abnormally high and others as abnormally low. Abnormality is intrinsic to the model and generated by the model. The abnormals generated by the normal distribution curve may or may not be regarded as abnormal by significant others in their social groups. The investigator studying sociocultural correlates of behavior using a statistical model must beware of interpreting the statistical variation within his normative population as differences having substantive significance in the social world.

In view of the assumptions and limitations of the statistical model, it is my opinion that a standard statistical model based on a single distribution is a valid perspective in the study of sociocultural correlates of learning disabilities and behavior problems when:

1. it has been established that the investigator is dealing with a single population, statistically and socioculturally, and,
2. that the distribution of the characteristic in the population being studied is normal, and
3. that there is a value consensus in the population being studied that the "problem" behaviors are of substantive significance and not simply an artifact generated by the model.

If the statistical model of "normal" is used in circumstances which do not meet the above assumptions, then some type of multiple-norms are needed clearly differentiating the populations for which different normative frameworks are appropriate.

The Social System Model of Normal

A social system consists of two interlocking structures: a patterned set of statuses and their associated roles, and a normative structure. The statuses in a social system are the positions available to individuals participating in the system. Roles are the behaviors of persons filling particular statuses. Persons occupying a particular status behave in a certain manner and perform certain duties and functions which comprise the role associated with that status. Persons participating in any social system share certain common expectations as to how persons occupying various statuses ought to act in performing their roles. These role expectations define the behaviors which are acceptable to other members of the system. Role expectations differ for different statuses. Collectively, they form the core of the normative structure of the social system. Norms define the behaviors which are obligatory for any person holding a particular status, the behaviors which are optional, and the behaviors which are prohibited.

The amount of leeway which an incumbent may take in fulfilling the normative expectations for his status varies from status to status and system to system, but there is always some flexibility in the application of sanctions. The role expectations may be very explicit and formally written into laws and codes or they may be informal, unwritten understandings. In either case, a person violating the norms of his status will receive negative sactions, punishments from other members of the system. Those fulfilling the expectations of their status in an exemplary fashion will be positively sanctioned, rewarded by other members of the system.

The norms of a social system operate at two levels — the general behavioral expectations for anyone holding any status in the system and the specific behavioral expectations unique to each status. Thus, "normal" performance is both social system specific and status specific. It is not possible to speak of "problem" behavior or "learning disability" without first specifying the social system which regards such behavior as a "problem" and the role in that system which the child is not "learning". The reference point for evaluation is always the normative structure of the system in question and the perceptions of system members as to whether an individual's behavior is acceptable for one occupying his status.

The extent to which any particular behavior is regarded as supranormal, normal, or a "problem" can be empirically determined by noting the direction and degree of positive and negative sanctions illicited in response to various types of behavior by other status incumbents. By noting the behaviors which are positively sanctioned and those which are negatively sanctioned, the investigator can map out the normative structure of a particular social system.

There are three major strategies which a social system may use in coping with the "disabilities" or "problem" behavior of members.

Other members of the system may attempt to "normalize" the deviant's behavior so that he or she is able to meet group expectations. Normalization may be accomplished through intensifying the socialization processes, through education, rehabilitation, psychotherapy, behavioral management, and other similar programs. When normalization strategies are used, the deviant member is not removed from the group and expectations for role performance remain essentially intact.

A second strategy which a social system may use in dealing with problem behavior is that of assigning the deviant member to a special status in the system. This special status has role expectations tailored to fit the non-normative behavior of the deviant member. The deviant is not expected to meet group expectations and, consequently, the deviant status is not valued as highly as a normal status. Often, occupying a deviant status is stigmatizing.

A third strategy which a social system may use in dealing with a member whose behavior is a "problem" is to deprive him of his status in the group. This strategy defines the deviant as an "outsider" who is beyond the norms of the group. A policy of exclusion or exemption is basically a policy of estrangement because it treats the problem member as a stranger.

Basic to the entire social system perspective is the recognition that "disabilities" and "problem" behaviors are socially defined within some normative structure. The definition of the types of behaviors which come to be regarded as social problems is essentially a political process. Becker argues that the normative structures of a group are decided in political conflict and that "the questions of what rules are to be enforced, what behavior regarded as deviant and what people labeled as outsiders must also be regarded as political" (Becker, 1963, p. 7). Horowitz and Liebowitz (1968) state that "the decision to treat deviance as a social problem is itself a political decision. It represents the political ability of one group of decision-makers to impose its value sentiments upon decisions concerning deviance. A comprehensive analysis of defiance must include political factors by determining which decision-makers define deviance as problem and indicate why they consider deviance a problem." Studies of behavior problems from a social system perspective are concerned not only with the individual whose behavior is regarded as a "problem" but with the norms of the persons defining the behavior as problematic and the political process by which certain groups are able to determine which set of rules shall be enforced. Thus, the social process by which learning disabilities and behavior problems are defined becomes one aspect of the study of learning disabilities and behavior problems. The categories of pathology and symptoms which tend to be taken as "givens" under other perspectives, also become an aspect of investigation.

The decision to use a social system perspective in the study of sociocultural correlates of learning disability and behavior problems has implications for the research design and the types of questions which investigation is likely to explore.

First, the social system perspective shifts the focus of interest. Instead of concentrating entirely on the characteristics and behavior of the person labeled as having "learning disabilities" or "behavior problems", the research is also interested in the normative structure of the social system which is defining the person as abnormal and the processes by which that particular definition of the situaton has gained ascendency in that system.

Second, from the social system perspective research perceives abnormality as relative to the social context and the particular social systems in which the person is operating and the statuses and roles he is playing in those systems. A person is "normal" when he meets the expectations of the norms of the social system in which he is operating. His behavior may be regarded as abnormal "in one system and "normal" in another. Consequently, he may be "disabled" at one time during the day or during one period of his lifetime when operating in one system and non-disabled at another time during the day or during another period in his lifetime. Disability is social system specific.

Third, from a social system perspective research treats each sociocultural group as a viable social system with a normative structure that functions to define the reciprocal privileges and structure obligations of persons occupying various statuses in the system. Differences in the interpretation and evaluation of behavior are accepted as differences not as aberrations or errors.

Fourth, research, instead of concentrating primarily on etiology, is concerned with how various roles are defined in different sociocultural groups; what the expectations are for performance in those roles; what system of sanctions are used to encourage normative behavior and discourage non-normative behavior; what methods of socialization are used so that children internalize norms and adopt certain patterns of behavior; and so forth. From the social system perspective research is concerned with the differing socialization milieux in which the child must operate and the possibility that culture conflict between different socialization settings may place the child in a situation in which behavior valued and rewarded in one social system is de-valued and ridiculed in another. How behavior is defined; the types of social system in which the child lives; and the roles which he plays in those social systems are central concerns.

The social system model is particularly appropriate for the study of sociocultural correlates of learning disabilities and problem behavior precisely because these "pathologies" are ill defined; are primarily behavioral definitions generated within one social system- the public school; and do not have any clear cut biological basis.

A Research Agenda from A Social System Perspective

In this part of the paper, I shall attempt to outline some approaches to the study of sociocultural correlates of learning disabilities and behavior problems from a social system perspective using preliminary findings from studies of elementary school children which we have been conducting in California for illustrative purposes. The specific focus will be on the development of mechanisms for the comprehensive assessment of children which are culturally sensitive and which measure adaptive behavior (social role performance) in non-academic settings. After presenting a brief description of the data base and the measure of sociocultural characteristics used in the study, specific findings and issues will be discussed.

The Epidemiology of Exceptionality

The epidemiology of exceptionality is a study of 2,100 California public school children 5 through 11 years of age. During the 1972-73 school year, the mothers of 700 Black, 700 Chicano/Latino, and 700 Anglo-American children were interviewed. Using data from the ethnic survey conducted annually by the Department of Education, each subsample was independently selected to represent the public school population of California for that ethnic/racial group.[2] We were able to locate 1,924 of the children and to test them with the 1974 revision of the Wechsler Intelligence Scale for Children (WISC-R)

and the Bender Gestalt Test. In addition, each child was given a series of physical dexterity tests. The tested subsamples consisted of 616 Black, 620 Chicano/Latino, and 688 Anglo-American children. Mothers were interviewed in their homes by women of the same ethnic group as the mother. Chicano/Latino interviewers were required to speak, read, and write Spanish. The Spanish version of the interview was used when preferred by the respondent, 31.8% of the Chicano/Latino cases. Mothers were paid for the interview and signed consent forms permitting their children to be tested. The percentage of mothers of children initially selected for the sample who agreed to participate was 87.4% for the Anglo-American mothers, 84.1% for the Chicano/Latino mothers, and 73.3% for the Black mothers. The WISC-R, Bender Gestalt, and physical dexterity measures were administered to the children during school hours in two, forty minute testing sessions held on different days. A total of 71 certified school psychologists and second year graduate student interns did the testing.

The Measure of Sociocultural Modality

During the interview, each mother was asked a series of 40 questions relating to the sociocultural characteristics of the family. These questions were factor analyzed and nine factors were identified. Each factor was given a name which describes the items appearing in the factor. In the following descriptions of the content of the nine factors, factor loadings for each item are presented in parentheses.

Factor 1: Family Structure. Family structure is based on three variables: the sex of the head of household (.93); the marital status of the mother or mother substitute (.78); and whether the child is living with both biological parents or with only one biological parent (.92). This factor accounted for 32.5% of the total variance.

Factor 2: Anglization. Anglization consisted of five questions: highest grade completed by the head of household (.49); highest grade completed by the mother or mother substitute (.53); whether the head of household was reared in the United States outside the South versus reared in a foreign country or reared in the South (.81); whether the mother was reared in the United States outside the South versus reared in a foreign country or reared in the South (.86); and an interviewer rating of the level of English language usage of the respondent (.68). This factor accounted for 23.3% of the total variance.

Factor 3: Occupation of Head. Occupation of head consisted of a single variable. The respondent described the occupation of the person who provided the primary financial support for the family and that occupation was coded into nine occupational levels corresponding to the gradations of the Duncan Socioeconomic Index (Reiss, 1961). These levels can be generally described as unemployed; laborers; operatives; craftsman; clerical workers; salespersons; self-employed proprietors; salaried managers and officials; and professionals. This factor accounted for 9.0% of the total variance.

Factor 4: Family Size. Family size consisted to two items: the number of full brothers and sisters of the sample child (.78) and the total number of persons living in the household at the time of the interview (.81). This factor accounted for 8.0% of the total variance.

Factor 5: Parent-Child Relationship. Parent-Child Relationship consisted of two items: the biological relationship between the child and the head of the household (.61) and the biological relationship between the child and the mother or mother substitute. This factor accounted for 7.4% of the total variance.

Factor 6: Sense of Efficacy. Sense of Efficacy included three Likert-type questions dealing with the respondent's locus of control and sense of powerlessness. Persons with low scores on the efficacy measure believe that a person's success or failure is predetermined at birth (.54); that a person has to live for today and let tomorrow take care of itself (.60); and that planning makes people unhappy since plans hardly ever work out (.69). This factor accounted for 6.5% of the total variance.

Factor 7: Source of Income. Source of Income includes two questions: Whether or not the head of household provides most of the family income (.79), and an ordinal ranking of sources of financial support for the family (.82). This factor accounted for 5.5% of the total variance.

Factor 8: Urbanization. Urbanization consists of the size town in which the head of household was reared (.72) and the size town in which the mother was reared (.75). Responses were categorized farm; small town; small city; and large city. This factor accounted for 4.3% of the variance.

Factor 9: Community Participation. Community Participation contained four questions which asked the respondent to report how often she participated in meetings and events at the child's school (.54); how often she participated in meetings at church or with religious groups (.41); how often she met with groups working for the welfare of the community but not related to church (.41); and how often she participated in social affairs with other persons not related to church (.28). This factor accounted for 3.5% of the total variance.

Measures of Socialization

Role Boundaries. During the interview with the mother, the interviewer asked the mother a series of questions intended to measure the child's adaptive behavior, the Adaptive Behavior Inventory for Children (ABIC). These questions asked about the child's social role performance in the family, neighborhood, and school. Each question had three categories of response: a latent category which indicated that the child had never performed a particular role; an emergent category which indicated that the child performed a role occasionally and/or under supervision; and a mastered category which indicated that the child regularly performed a particular social role without supervision or adult assistance. Some respondents, however, reported that the child did not have an opportunity to perform certain roles. Thus, a child's role performance could be bounded by environmental factors, such as living in a rural area which did not provide opportunities for some types of activities. Role performance could also be bounded by cultural restrictions on the types of activities permitted a child of his or her age and sex. For example, many Mexican-American mothers reported that they did not permit their daughters to participate in any activities which would keep them away from home overnight. Such behavior is not culturally permissable for unmarried Mexican-American girls from traditional families.

We totaled the number of "no opportunity" and "not allowed" responses given by each mother and designated the score as a measure of Role Boundaries. Scores ranged from 0 to over 30. The average score was 11.25 with a standard deviation of 9.75.

Anonymity was a second measure derived from responses to the Adaptive Behavior Inventory. It consists of the total number of "Don't Know" responses given by the mother or mother substitute. We theorized that caretakers who know relatively little about the activities of a child are providing a socialization setting in which the child is relatively anonymous, and unknown. Such an environment could significantly affect a child's development. The mean number of "Don't Know" responses was low, 2.35, and skewed. The standard deviation was 3.00.

Need for Pluralistic Norms of Academic Measures

In the first section of this paper, the assumptions of the statistical model for defining normal behavior were reviewed and the difficulties of utilizing a statistical model when populations are socioculturally distinct were discussed. In the assessment of "learning disabled" children, the clinician is typically concerned with those children who are failing to meet the expectations which schools have for their academic performance. Typically, the school psychologist uses an individual measure of "intelligence" or a standardized "achievement" test as part of the assessment procedure and interprets the student's performance relative to the standard norms without systematically investigating the child's sociocultural background. Our findings indicate that this practice cannot be defended either from a statistical perspective or from a social system perspective.

Ethnic Differences in Sociocultural Modality

Table 1 presents the mean scores for each ethnic group on each sociocultural factor and tests the statistical significance of ethnic differences using one-way analysis of variance.

Table 1

Mean Socialization Scores and Correlations with Full Scale WISC IQ of 1,924 Black, Chicano/Latino, and Anglo-American Children 5 through 11 years of age

		BLACK N=616		CHICANO/LATINO N=620		ANGLO-AMERICAN N=688		TOTAL N=1,924		
	scoring Range	Mean	SD	Mean	SD	Mean	SD	Mean	SD	F-Ratio
Family Structure	0-3	1.75	1.35	2.39	1.09	2.45	1.01	2.22	1.18	65.86**
Anglization	0-10	6.10	1.97	4.24	3.02	8.05	1.78	6.15	2.80	460.42**
Occupation Head	0-9	2.95	2.25	2.75	2.08	5.26	2.52	3.66	2.56	258.02**
Size of Family	2-N	7.78	3.80	9.17	4.10	6.80	2.80	7.92	3.73	76.37**
Relation to Parents	0-2	1.75	0.57	1.85	0.43	1.80	0.49	1.80	0.50	7.19**
Sense of Efficacy	0-3	2.21	0.98	2.00	1.13	2.69	0.59	2.31	0.97	97.69**
Source of Income	0-3	2.11	1.31	2.51	1.03	2.81	0.63	2.48	1.06	79.53**
Urbanization	0-6	3.87	1.80	3.65	1.73	3.88	1.71	3.80	1.75	3.85*
Community Participation	0-6	4.25	1.94	2.72	2.01	4.19	1.78	3.71	2.04	141.22**
Role Boundaries	0-N	7.18	7.48	11.89	10.37	14.53	9.67	11.25	9.75	110.73**
Anonymity	0-N	2.25	2.96	2.94	3.45	1.88	2.40	2.36	3.00	23.81**

*Significant beyond the .05 level
**Significant beyond the .01 level

The average scores of the three ethnic groups differ significantly beyond the .01 level on every sociocultural modality factor except Urbanization. Anglo-American and Chicano/Latino children are significantly more likely to come from intact families. Anglo-American students are more likely than Black children to come from well educated families in which the parents were reared outside the South, while Chicano/Latino children are most likely to come from families in which the parents have relatively little formal education, are foreign born, and do not speak English. Anglo-American children are more likely to come from white-collar homes while Black and Chicano/Latino children are more likely to come from blue-collar homes. Anglo-American families are more likely to be supported by the earnings of a family member while Black families are least likely to be self-supporting. On the other hand, Black families are most likely to participate in community affairs and Chicano/Latino families are least likely to participate. Anglo-American mothers are most likely to report Role Boundaries for their children and Black parents are least likely to report such boundaries. Finally, Chicano/Latino mothers are less likely to have a comprehensive knowledge of the child's activities than Black or Anglo-American mothers, especially those activities which take place in a school context.

Table 2 reports the Pearson correlation of each factor with the Full Scale IQ of the child on the WISC-R. The only factor which is not significantly correlated with Full Scale IQ for any of the three individual ethnic groups is Urbanization.

We conclude that the Anglo-American, Chicano/Latino and Black children in our three subsamples come from significantly different sociocultural backgrounds and cannot be treated as if they are a single population with a common lifestyle and a similar cultural heritage. On those factors most highly correlated with scores on the WISC-R (Occupation of Head, Anglization, Sense of Efficacy, and Source of Income), Anglo-American children are clearly in the most advantaged positions. We cannot draw any conclusions about the relative learning potential of the children in our sample on the basis of the standard norms. Their scores on the standard norms can be interpreted as a measure of their relative *achievement* in relation to the culture of the public school but they provide no basis for making any inferences about their relative *aptitude*, i.e., intelligence or learning potential.

Table 2

Socialization Correlates of WISC Full Scale IQ
700 Black, 700 Chicano/Latino, 700 Anglo-American Children

CHICANO/LATINO				BLACK				ANGLO-AMERICAN			
	r	R	% of Variance		r	R	% of Variance		r	R	% of Variance
Anglization	.33**	.33	10.9	Anglization	.26**	.26	6.7	Occupation	.31**	.31	9.5
Sense of Efficacy	.29**	.37	13.7	Source of Income	.24**	.33	10.6	Source of Income	.25**	.35	12.0
Size of Family	-.21**	.39	15.0	Size of Family	-.21**	.36	12.7	Anglization	.24**	.36	13.3
Role Boundaries	-.03	.40	15.6	Sense of Efficacy	.18**	.37	13.7	Size of Family	-.12**	.37	14.0
Occupation	.17**	.40	16.2	Role Boundaries	.15**	.38	14.4	Family Structure	.15**	.38	14.5
Community Participation	.21**	.41	16.7	Urbanization	.05**	.38	14.6	Relation to Parents	.06	.39	14.9
Relation to Parents	.04	.41	17.2	Community Participation	.11*	.38	14.8	Sense of Efficacy	.13**	.39	15.1
Family Structure	-.04	.42	17.3	Family Structure	.09*	.39	14.8	Anonymity.	.02	.39	15.4
Source of Income	.05	.42	17.4	Occupation	.20**	.39	14.9	Urbanization	.08	.39	15.6
Urbanization	.10*	.42	17.4	Relation to Parents	.04	.39	15.0	Community Participation	.12**	.39	15.6
Anonymity.	-.12*	.42	17.4	Anonymity.	.01	.39	15.0	Role Boundaries	.07	.39	15.6

Ang (.93)+Effic(2.10)-FamSize(.39)-Role B(.10)+Occup(.51)+86.75=
Mean for Sociocultural Group
Standard Error = 12.3

Ang(1.01)-FamSize(.47)+Source In(1.92)+Effic(1.30)+Role B(.15)+77.00=
Mean for Sociocultural Group
Standard Error = 12.2

Ang(.87)-FamSize(.51)+Occup(1.14)+Source Inc (2.78)+FamStruc(1.17)+82.79=
Mean for Sociocultural Group
Standard Error = 13.0

*Significant beyond the .05 level
**Significant beyond the .01 level

The average score of the children in each of the subsamples on the Full Scale WISC-R was 87.6 for Black children, 91.5 for Chicano/Latino children, and 103.0 for Anglo-American children. The differences in these mean scores is statistically significant ($p<.001$), indicating that the children in the three subsamples *cannot* be treated as a single population.

An Approach to Pluralistic Norms

There are five premises which form the basis for our approach to the assessment of culturally distinct populations that cannot be studied within a standard statistical model.

First, tests measure only what a person has learned. Biological intellectual capacity (the genotype) cannot be measured directly. An individual's genetic potential is always expressed through behavior acquired in a social and cultural setting, his phenotype. Thus, all tests are basically measures of achievement and all test scores are influenced by a wide variety of environmental factors as well as the person's innate capacity for learning.

Second, all learning takes place in a sociocultural setting. No test is "culture free." However, some types of tests may be more "culture fair" than others because the materials covered in the test are present in more than one cultural tradition and persons from different cultural traditions have equal opportunities to acquire those particular skills or master those particular concepts.

Third, the distinction between tests of "intelligence" or "aptitude" and tests of "academic achievement" is erroneous. Jencks makes a succinct statement on this point. "In practice, however, all tests measure both aptitude and achievement . . . . If two students have had the same opportunity to acquire verbal skills, and if one has picked them up while the other has not, the test does indeed mea-

sure "aptitude." But if one child has been raised speaking Spanish and another English, the test measures the Spanish-speaking child's mastery of a foreign language. If the Spanish-speaking child does worse than the English-speaking, this shows lower achievement in this area, but it need not imply less aptitude . . . . When everyone is equally well prepared, achievement tests become aptitude tests. When people are unequally prepared, aptitude tests become achievement tests." (Jencks, 1972, p. 56). Thus, whether a test can be interpreted as a test of "achievement" or a test of "aptitude" or "intelligence" depends upon the extent to which the persons whose performances are being compared have had an equal opportunity to learn the material in the test. The differentiation between "achievement" and "intelligence" or "aptitude" tests does not rest upon the test form or content, per se.

Our approach to pluralistic norms is based upon the fundamental premise that all tests are achievement tests which can be interpreted as measures of "aptitude" only when an individual's performance is being compared with others who (1) have had similar opportunities to learn the skills and information covered in the test, and (2) have been similarly motivated and rewarded for learning those skills.

From this perspective, the technical problem in assessing "aptitude" is one of *identifying as precisely as possible the appropriate normative framework within which to interpret each individual's performance so that he is being compared only with others who have had similar opportunities to learn the materials in the test.*

Fourth, the norms for the standardized, norm-referenced tests currently used by the public schools are *not* universally applicable to all children attending the public schools as the basis for estimating the child's *aptitude*. Standard norms do provide information on the child's current level of *achievement* relative to other students of his age but they may or may not provide valid information on his learning potential. Such inferences can be made only when the student is being compared with persons of the same age from the same sociocultural background.

Fifth, some recent work by educational historicans provides valuable insights into historical factors producing systematic racial, ethnic, and socioeconomic differences on standardized tests. (Karier, 1973; Katz, 1971). They conclude that the bureaucratic, organizational form of the public school replicates the structure of the industrial order in its centralized administration, classification of scholars by grades, emphasis on professionalism, and standardization of the curriculum. Fear that the illiterate immigrant might destroy American institutions led to public school programs intended to acculturate and "Americanize" immigrant children. Cultural homogenization blurred cultural distinctions through a monocultural, educational "melting pot" in which all children were to be Anglicized. Standardized tests of "achievement" and "aptitude" are designed to predict which children will succeed in the public schools as they exist today: Anglocentric, monocultural, class biased, standardized, and centralized bureaucracies administered by professional educators. Tests are very school-system specific in their predictive powers. Persons from lower class background and/or non-Anglo backgrounds have more difficulty with the tests just as they have, historically had more difficulty coping with an American educational system originally designed by the dominant Anglo majority to "socialize" the children of "foreign" cultures. Because a primary function of educational institutions is allocating persons to adult roles and statuses in American society (Parsons, 1959; Cicourel and Kitsuse, 1963; Turner, 1960; Jencks, 1963) it is essential that methods be devised for identifying a student's aptitude i.e., learning potential, as well as his level of current functioning i.e., his achievement. We are proposing that both achievement and aptitude can be estimated with the same standardized instruments by using different sets of norms.

Sociocultural Correlates of Full Scale WISC-R Scores

We calculated three stepwise multiple correlation coefficients (R), one for each ethnic group, using the nine sociocultural factors and the two socialization measures as independent variables and Full Scale WISC-R IQ as the dependent variable. Table 2 presents the results of those calculations. The eleven variables accounted for approximately 17% of the variance in Full Scale WISC-R IQ's for the Chicano/Latino group; 15% of the variance for the Black group; and 16% of the variance for the Anglo-American group. However, the first five variables in the stepwise solution were able to account for

most of the explained variance for each group: 16% for the Chicano/Latino sample, 14% for the Black sample, and 15% for the Anglo-American sample. For this reason, we decided to use the regression equation derived from the first five variables for estimating pluralistic norms.

We found that the intercepts and slopes for the equations for the three ethnic groups were significantly different ($p<.001$). This finding is further within two standard errors from that mean. Using the unique configuration of each person's sociocultural background and ethnic group, we can estimate the mean Full Scale IQ score for a normative population consisting of persons from similar backgrounds. We can then determine where the individual falls in the distribution of scores for the culturally appropriate normative population by converting the IQ into a standard score based on the pluralistic norms. Of course, standard scores can be readily converted into percentile scores and the child's relative position in the distribution of scores for persons of similar sociocultural background can be reported either as a standard score or a percentile. This procedure should provide a more accurate basis for making inferences about a child's estimated learning potential.

One example will suffice to illustrate how pluralistic norms might be useful in interpreting a child's performance on the WISC-R. Juan is a 7 year old Chicano/Latino boy who scored 113 on the standard norms for the WISC-R. Thus, his current level of functioning (CLF), i.e., his achievement in terms of the dominant culture of the school, is well above average but not outstanding. He is performing at approximately the 80%ile in relation to the standard norms. We would predict that he will probably succeed in the regular program of the school without supplementary help, will be an adequate student, and will probably perform well in college. However, when we interpret Juan's performance relative to the pluralistic norms, we get a slightly different picture of his potential. His sociocultural modality scores are as follows: Anglization, 7; Family Size, 5; Occupation of Head of Household score, 1; Role Boundaries, 23; and Sense of Efficacy score, 1. Translating these scores into a more meaningful description, we find that Juan comes from a family of four. He lives with his mother and two other children. His mother is head of the household. The family's income comes from welfare and child support. Juan's mother, who spent most of her childhood in Los Angeles, and did not finish high school, does not work outside the home. The family lives in a four room rented house and has moved three times in the last five years. Juan's mother feels powerless, unable to control her future. The family speaks Spanish some of the time in their home and when they are out with friends in the community. Although Juan's mother speaks English fluently, her Spanish accent is noticeable.

The average IQ score for children of Juan's sociocultural modality is 91.6. His score of 113 is 22.4 points higher than the mean for his normative group, about 1.8 standard errors, approximately the 95th percentile. Interpreted against the pluralistic norm, Juan's estimated learning potential (ELP) is probably in the upper five per cent of the population. An educational plan geared to his estimated learning potential, not just his current level of functioning (CLF), might further enrich Juan's educational opportunities and eventual achievements.

Need for Further Research in Area of Sociocultural Correlates of Motor Perceptual Skills

The Bender Gestalt Test consists of nine figures which are presented one at a time and which the subject is asked to copy on a blank sheet of paper. Bender regards the test as a test of visual-motor perception determined by biological principles of sensory motor action which depend upon the maturational level of the individual and his emotional state (Koppitz, 1964, p. 1) Bender reports that most children are able to copy all nine designs without error by the time they are eleven years of age. Most users regard it as either a test of visual-motor perception or as a test of emotional adjustment.

The Koppitz system of scoring attempts to differentiate between distortions on the Bender which primarily reflect perceptual difficulties or immaturity and those which do not appear to be related to age and are interpreted as emotional factors. In our scoring of the Bender, we followed the Koppitz developmental scoring system for young children (Koppitz, 1964).

Table 3 presents the mean raw total scores by age and ethnic group for the Bender-Gestalt. A high score indicates a large number of errors and is interpreted as a low performance on the figures. Ethnic differences are statistically significant beyond the .01 level at all age levels but three. The trend in

Table 3

Raw Mean Total Scores by Age and Ethnic Group

Overall Score, Bender Gestalt Test

Age	Anglo-American		Chicano/Latino		Black		Total		F	L
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
5.0-5.5	10.72	3.18	10.71	3.69	14.5	4.0	12.14	3.92	4.24	NS
5.6-5.11	9.60	4.04	10.93	4.58	12.40	3.90	10.93	4.34	6.01	.01
6.0-6.5	7.94	2.94	9.65	4.26	10.73	3.58	9.02	3.78	7.41	.001
6.6-6.11	6.84	3.79	7.31	2.86	9.29	3.44	7.84	3.56	7.34	.001
7.0-7.5	5.00	2.89	5.32	2.84	7.67	4.22	5.93	3.46	8.50	.001
7.6-7.11	3.55	2.74	4.69	3.59	7.60	3.48	5.22	3.69	20.07	.001
8.0-8.5	3.14	2.33	4.50	3.24	5.40	3.23	4.37	3.12	5.94	.01
8.6-8.11	3.37	2.93	4.67	2.49	5.45	3.11	4.38	3.01	6.05	.01
9.0-9.5	3.28	3.02	3.96	4.72	4.56	3.42	3.97	3.89	1.25	NS
9.6-9.11	2.48	1.80	3.98	2.68	4.92	3.05	3.79	2.75	11.29	.001
10.0-10.5	1.48	1.85	2.69	2.21	4.64	2.81	2.86	2.63	23.42	.001
10.6-10.11	1.76	1.52	2.38	2.29	3.60	2.49	2.55	2.27	7.61	.001
11.0-11.5	1.74	1.67	2.62	2.33	4.17	2.83	2.71	2.53	13.85	.001
11.6-11.11	1.94	2.16	2.06	2.35	3.30	2.98	2.41	2.58	4.25	.05
F		52.10		35.73		38.11				
Sig. Level		.001		.001		.001				
Interaction:	F	.96	Sig. Level NS							

mean performance is similar at all age levels. In general, Black children make the most errors, Chicano/Latino children are intermediate, and Anglo-American children make the least errors. Mean scores are significantly different over age for all ethnic groups, indicating that there is a decided maturational factor involved. There is no interaction between age and ethnic group, indicating that the maturational effects are similar for all ethnic groups.

It is clear from these findings that children in the three ethnic groups cannot be treated as members of the same population, statistically. Therefore, we examined the sociocultural correlates of total raw scores on the Bender Gestalt test within ethnic group using stepwise multiple correlations. There was no significant correlation between total raw scores on the Bender and any sociocultural characteristic for the Anglo-American children. For Chicano/Latino children, three sociocultural variables could account for 2.2% of the total variance in Bender scores: Occupation of the Head (r=.11), Anonymity (r=.08) and Family Structure (r=.05). For Black children, three sociocultural factors could account for only 2.1% of the total variance in Bender raw scores: Family Size (r=.11) and Sense of Efficacy (r=.08). This line of research is particularly interesting because the Bender-Gestalt test has traditionally been regarded primarily as a measure of the biological mechanisms underlying visual motor perception and, as such, has been regarded as a test which is not likely to be influenced by sociocultural factors. If this is the case, and our findings tend to support this position, then scores on the Bender can legitimately be interpreted within a pathological model using one standard set of age-graded norms. How then can we explain the consistently larger number of errors made by Black children at most age levels on most figures? How does performance on the Bender correlate with school success? Are the scores correlated with physical dexterity measures? These are all areas needing further exploration.

Need for Further Research in the Area of Children's Adaptive Behavior in Family, Community, and School

When clinicians speak of social adjustment, social maturity, or social competence, they refer to an individual's ability to perform successfully in the social roles considered appropriate for his age and sex. The American Association on Mental Deficiency has developed a detailed construct which defines adaptive behavior as the second, co-equal dimension of behavior which is to be assessed in determining whether an individual is mentally retarded (Grossman, 1973). In general, adaptive behavior is conceptualized as an individual's ability to play ever more complex social roles in a progressively widening circle of social systems. As a child matures, the behavior standards of society become more demanding and the number and complexity of the social roles which he is expected to play increases. His ability to cope with these increasing expectations for social role performance constitutes his adaptive behavior.

An earlier study concluded that the two dimensional definition of mental retardation advocated by the AAMD is justified because (1) there was a relatively low correlation between a measure of adaptive behavior and scores on IQ tests — linear correlations ranged from -.13 to -.31 at different age levels, (2) the measure of adaptive behavior seemed to be identifying significant numbers of persons whose competence in social roles belied their low IQ test scores, and (3) discrepancies between adaptive behavior and IQ test scores were particularly marked for persons; from minority groups and/or lower social status (Mercer, 1973). Subsequently, we have been engaged in developing a measure of adaptive behavior appropriate for children 5 through 11 years of age, the Adaptive Behavior Inventory for Children (ABIC). After a brief description of the ABIC, I will present some preliminary findings concerning sociocultural correlates of adaptive behavior in young children.

Development of the Adaptive Behavior Inventory for Children (ABIC)

The inventory is designed to measure the social role performance of children 5 through 11 years of age in the family, community, neighborhood, and school. Items for the inventory were collected from a variety of sources: the scales used in the Riverside epidemiology (Mercer, 1973); information from follow-up interviews with mothers of children in classes for the educable mentally retarded; and information from in-depth interviews held with Anglo-American, Black, and Mexican-American mothers of all social status levels in which they described, in detail, the activities of their children at home and in the neighborhood. The original pool of items consisted of 480 questions. These questions were pretested on about 1000 mothers and fathers of children 5 through 11 years of age from all ethnic groups and socioeconomic levels who were contacted through various organizations. On the basis of the pre-test, some questions which proved to be ambiguous or redundant were either eliminated or modified and age-graded questions were placed at the approximate age level at which the behavior was rated as "emergent". Non-age-graded questions were kept in a separate category.

In the final standardization of the ABIC, the mother or principal caretaker for the child responded to the questions and responses were coded Latent (0); Emergent (1); or Mastered (2). (See page 18 of this paper.) Responses of "No opportunity" or "Not allowed" were coded as Latent (0) because the child had not demonstrated his or her competence in that role. Responses of "Don't Know" were assigned a pro-rated score based on the average score of the two preceding questions and the two following questions. Questions were organized into six subscales according to the social system in which the behavior takes place and/or the type of role performance required. Item assignment was based on independent item sorts done by 10 qualified raters. There was complete agreement by all raters on the placement of 115 of the 221 items in the standardized version of the ABIC. Following some re-definition of the categories, a different set of 10 raters sorted those questions on which there had not been 100% agreement. Ultimately, there was 100% agreement on 115 items and more than 70% agreement on 72 items. Twenty-two items were assigned in approximately equal proportions to two different categories and, consequently, have been scored as part of two subscales. The twelve remaining items were not used as part of the measure of adaptive behavior.

The Six Subscales of the ABIC

Family role performance (48 items) is that sphere of behavior in which the child plays the role of son or daughter, brother or sister, while living in household with his parents (or a parent) and probably other children. These are behaviors which have to do with the child's temperamental style; how well he gets along with family members; the things he could be expected to do around the house to help out; his talking and interacting with other family members and relatives; his skills with tools and equipment needed for food preparation; his preparing of food for himself and for the family; his playing and helping with younger children; his repairing of his and the families belongings; his skills with the tools and equipment needed for repairs.

Community role performance (40 items) includes the role of neighbor and citizen in its scope and provides information about the behavior of the child in the enlarged environment of neighborhood and community. Specifically, these are behaviors which indicate the child's tendency to venture beyond the home, i.e., his level of mobility and independence in going out of the house, about the neighborhood and community, or going on visits to friends and relatives; his knowledge of the names of families and pets in the neighborhood; his activity as a volunteer—helping neighbors or community groups; his participation in social, political, religious, or recreational community activities; his knowledge of community news; his use of community facilities; how well he gets along with grownups in the neighborhood; whether he has had trouble with authorities.

Peer group role performance (24 items) has to do with the play behavior of the child and his interaction with other children around his own age. These behaviors include his reaction to the behavior of other children while playing with them; how well he gets along with other children; his behavior toward children in the play group; his meeting or going about with friends and doing various kinds of things; whether he plays certain kinds of games.

Student role performance (33 items) taps the behavior of the child in relation to his activities at school and his interaction with his teachers and classmates. Specifically, these are behaviors about knowing his classmates, doing homework, and his study habits; about helping teachers at school; about holding class offices or serving as monitors or other helpers; his behavior on the playground; his participation in social affairs and athletic activities at school; his participation in school competitions and nonacademic learning activities or projects; how well he gets along with schoolmates and teachers; his school attendance.

Earner/consumer role performance (26 items) has to do with the child's economic behavior, i.e., his grasp of the meaning of money, his knowledge of monetary values, his shopping skills, and his activities in earning money or acquiring money. Specifically, these behaviors include the carrying, handling, borrowing, and understanding the value of money; his knowledge about the brand names and values of products; his tendency to save money to buy later; whether he shops and level of shopping skills; the ways he earns money; paying for his own expenses; making contributions of his own money.

Self maintenance role performance (41 items) includes behavior which demonstrates the child's knowledge and skills in those areas which have to do with his own needs, health, body care, and safety as an individual, and his ability to meet unknown situations with self confidence and to maintain self control under stress or distraction. These behaviors have to do with the child's ability to identify himself and respond with his name; his tendency to be impatient, irritable and restless; his tendency to be fearful; his skills in making his needs known; behaviors which include dressing and fixing food for himself; protecting his health and body; his skills in watching out for his safety, like crossing streets; his skills in providing for his needs when out in the community; his skills in scheduling time and managing his own dates, appointments and affairs.

Sociocultural Correlates of Adaptive Behavior

Differences in mean raw scores on each of the subscales for children of the three ethnic groups in the sample were tested using analysis of variance. Table 4 presents the findings for 14 age groups categorized at six month intervals. There were no significant differences beyond the .01 level of probability in mean raw scores at any age level in reported performance in Family Roles and Peer Group Roles.

Table 4

Significance of Difference of Mean Raw Scores on Six Subscales of the Adaptative Behavior Inventory for Children Comparing Anglo-American, Chicano/Latino and Black Children

Age	Family Roles	Community Roles	Peer Group Roles	Student Roles	Self Maintenance	Earner/ Consumer Roles
5.0-5.5	NS	.01	NS	NS	NS	NS
5.6-5.11	NS	NS	NS	NS	NS	NS
6.0-6.5	NS	NS	NS	NS	NS	NS
6.6-6.11	NS	.001	NS	NS	NS	.001
7.0-7.5	NS	NS	NS	NS	NS	NS
7.6-7.11	NS	NS	NS	NS	NS	NS
8.0-8.5	NS	NS	NS	NS	NS	NS
8.6-8.11	NS	NS	NS	NS	NS	NS
9.0-9.5	NS	NS	NS	.01	NS	NS
9.6-9.11	NS	NS	NS	NS	NS	NS
10.0-10.5	NS	.01	NS	NS	NS	.01
10.6-10.11	NS	.01	NS	NS	NS	.01
11.0-11.5	NS	.001	NS	NS	.01	.001
11.6-11.11	NS	NS	NS	NS	NS	NS

There was one significant difference in Self Maintenance scores, four significant differences in Earner-Consumer Roles, and five significant differences in Community Roles. Altogether, there were 9 significant differences in 84 comparisons. The differences were not all in the same direction. We concluded that the ABIC scales would not need to be scored separately for each ethnic group but that the children could be regarded as coming from the same population for purposes of norming the scales. Scales were standardized on the entire sample of 2100 by setting the mean raw score for children categorized intervals to 50 and the standard deviation to 15.

We calculated stepwise multiple correlation coefficients (R) between the sociocultural modality items and the scaled scores on each of the six subscales of the ABIC for the entire sample of 2100 children. Tables 5a and 5b report the results of that analysis. Four sociocultural modality items were able to account for all of the reliable variance in Family Roles, Community Roles, and Peer group Roles while four sociocultural modality items could account for all of the reliable variance in Student Roles, Earner-Consumer Roles, and Self Maintenance. In no case did the sociocultural modality of the child explain more than 12% of the total variance. The variance explained was 6.5% for Family Roles; 11.8. % for Community Roles, 6.3% for Peer Group Roles; 7.4% for Student Roles; 7.7% for Earner-Consumer Roles; and 6.1% for Self Maintenance activities. When the total sample of 2100 children were included in a stepwise multiple correlation between sociocultural modality items and Full Scale WISC=r IQs, the multiple correlation coefficient was .49, accounting for 23.6% of the variance. Thus, correlations with sociocultural factors account for more than twice as much of the variance in IQ scores as in ABIC scores in the entire sample. This finding is similar to that found in the Riverside epidemiology of mental retardation (Mercer, 1973).

6.1

.01 .25 6.3

Summary

Implications for NIE Research Agenda

Fundamental Conceptual Issues

1. In the past, most educational research on "handicapping" conditions has been conceptualized from either a Pathological Model or a Statistical Model. The research agenda of NIE should be

Table 5a

Multiple Correlations of Sociocultural Modality Items
With Six Subscales of the Adaptive Behavior Inventory for Children

Total Sample (N=2100)

Family Roles	r	R	% Variance	Community Role	r	R	% Variance	Peer Group Role	r	R	% Variance
Community Participation	.17	.17*	2.9	Community Participation	.30	.30*	8.8	Community Participation	.20	.20*	4.2
Size Family	.11	.21*	4.6	Anonymity	-.20	.33*	11.0	Anonymity	-.15	.23*	5.4
Anonymity	-.14	.24*	6.0	Role Boundaries	-.07	.34*	11.3	Efficacy	.13	.24*	6.0
Family Structure	.08	.25*	6.3	Anglization	.16	.34*	11.7	Urbanization	.07	.25*	6.2
Role Boundaries	-.06	.25*	6.5	Relation to Parents	.04	.34*	11.8	Anglization	.08	.25*	6.3
Efficacy	.06	.26	6.6	Sense Efficacy	.12	.35	11.9	Head Occupation	.08	.25	6.4
Anglization	.00	.26	6.7	Head Occupation	.07	.35	11.9	Family Structure	.03	.25	6.5
Urbanization	.03	.26	6.7	Size Family	-.05	.35	11.9	Relation to Parent	.02	.26	6.5
Source Income	.02	.26	6.8	Urbanization	.04	.35	11.9	Size Family	-.05	.26	6.5
Relation to Parents	.02	.26	6.8	Family Structure	.00	.35	11.9	Source Income	.04	.26	6.5
Head Occupation	.01	.26	6.8	Source Income	.02	.35	11.9	Role Boundaries	-.01	.26	6.6

*Variables that account for reliable unique contribution to the explained variance beyond .01 level of probability

Table 5b

Multiple Correlations of Sociocultural Modality Items
With Six Subscales of the Adaptive Behavior Inventory for Children
Total Sample (N=2100)

Student Roles	r	R	% Variance	Earner-Consumer Roles	r	R	% Variance	Self Maintenance Roles	r	R	% Variance
Community Participation	.25	.25*	6.1	Community Participation	.23	.23*	5.4	Community Participation	.21	.21*	4.3
Anonymity	-.13	.26*	6.8	Anonymity	-.17	.26*	7.0	Anonymity	-.15	.24*	5.7
Sense Efficacy	.13	.27*	7.1	Anglization	.17	.28*	7.6	Efficacy	.11	.24*	5.9
Relation to Parent	.05	.27*	7.4	Source Income	-.01	.28*	7.7	Size Family	-.00	.25*	6.1
Urbanization	.06	.27	7.5	Relation Parent	.02	.28	7.8	Urbanization	.06	.25	6.2
Size of Family	-.02	.27	7.5	Urbanization	.07	.28	7.8	Relation Parent	.02	.25	6.3
Source Income	.05	.28	7.6	Efficacy	.11	.28	7.9	Family Structure	-.01	.25	6.3
Role Boundaries	-.01	.28	7.6	Occupational Head	.06	.28	7.9	Source Income	-.01	.25	6.3
Anglization	.13	.28	7.7	Family Structure	-.02	.28	7.9	Anglization	.10	.25	6.3
Family Structure	.02	.28	7.7	Size Family	-.06	.28	7.9	Role Boundaries	-.02	.25	6.3
Occupational Head	.08	.28	7.7	Role Boundaries	-.00	.28	7.9	Occupational Head	.05	.25	6.3

*Variables that account for reliable unique contribution to the explained variance beyond the .01 level of probability

planned so that there is a *balance* of research done from all three perspectives: Pathological, Statistical, and Social System.

2. Educational research in the area of deviance frequently confuses conceptual models. On occasion, researchers use a statistical model for defining "abnormality" and then shift to a pathological model when interpreting their data or use a pathological model to describe behaviors without verifying that there are biological factors involved. Another common problem is using a statistical model for comparing rates of "abnormality" in populations which are neither statistically nor socioculturally equivalent. NIE research planning in the area of educationally "handicapping" conditions should be sensitive to these conceptual confusions and insist that research designs reflect the conceptual model being used and the assumptions of that model.

3. Because of extensive use of the Pathological Model, educational research on handicapping conditions has tended to focus on deficits rather than assets. Deficits have been implicitly defined as those characteristics which mitigate against performance in one social system– the school. Traditionally, the schools have been monocultural, class biased, bureaucratic, and conformist. Consequently, there have been a disproportionate number of children from non-Anglo, lower class, non-conforming backgrounds who have been treated as deficient, as pathological cases. Some educational research needs to be refocused to study the cultural assets which children bring to the school from non-Anglo and non-middle class backgrounds.

4. Extensive use of the Pathological Model has resulted in research studies which interpret deviance as individual pathology. Consequently, research questions have tended to be phrased in terms of how to change the individual to better fit the school system. The burden of change has been placed upon the student. More research studies from a social system perspective which study the institutional processes of the school will tend to redress this emphasis by identifying ways in which the school could bear a greater burden of change.

Some Suggested Areas of Research from a Social System Perspective

1. More studies are needed of the normative structure of the public schools. These studies would examine both norms (role expectations) and sanctions. Such studies would include investigation of the role expectations (norms) for each of the important statuses in the system from the viewpoint of other participants in the system and from the viewpoint of occupants of the status. Specifically, role expectations for those occupying the status of student in a regular classroom should be studied from the perspective of the teacher, the principal, paraprofessionals, non-certificated staff, parents and students. Role expectations for those occupying "deviant" student statuses in the system, e.g., EMR student, physically handicapped student, "gifted" student should be studied from the perspective of the teacher, the principal, paraprofessionals, non-certificated staff, parents, and students in the regular program, and students occupying the deviant statuses. The same types of studies are needed of the role expectations for regular classroom teachers, special classroom teachers, resource room teachers, etc. from the perspective of students, parents, teachers occupying the status, teachers not occupying the status, principals, etc.

In addition, careful studies are needed of the sanctioning systems actually operating in the school, i.e., the system of rewards, punishments, deviant status placements, etc. which function to set normative boundaries and to exert social control. Specific attention is needed to the system of norms and sanctions through which the peer group maintains social control of students and the junctures at which the normative structure of the peer group and that of the formal organization may be congruent or incongruent. This type of study is particularly needed in the study of the student subcultures of students from non-Anglo and/or lower class backgrounds and in the study of peer response to students identified as "learning or behavior problems" by the formal organization of the school i.e. teachers, psychologists or counselors.

2. Careful studies are needed of the efficacy of various strategies which the schools use in coping with deviance, i.e., estrangement, deviant status placement, and normalization. The normalization process, currently known as "mainstreaming", is based on the notion of a continuum of educational services and the premise that every student should be kept in the regular program of the school to the extent possible. At one end of the continuum are those students who are able to succeed in the regular classroom with no special assistance beyond the regular program, probably 80% of the children enrolled in public education. Next come those students who may require some supplementary assistance from non-professionals such as mother helpers, para-professionals, or cross-age tutors. Next come those students who require supplementary educational services provided by trained professionals—speech therapists, remedial reading teachers, school psychologists, resource teachers, and similar educational specialists. However, children in this category are still maintained in the regular school program, either receiving special assistance in their own classroom or occasionally going to a location outside the regular classroom for supplemental services. Next on the continuum of services are those children who may spend as much as half their school day in programs outside the regular classroom but who still participate with other students whenever it is possible. Very few students probably need to be educated for the entire day in separate classrooms or in separate schools. This range of strategies for dealing with deviance needs to be studied from a social system perspective as well as from more traditional perspectives as an emerging phenomenon of great educational importance, especially in relation to "learning and behavior problems."

4. More careful investigations need to be made of the monocultural, Anglocentric value framework within which the public schools have operated, historically. This framework sets the normative expectations within which deviance is perceived and forms the sub-structure of current definitions of what constitute "learning and behavior problems." The "common-sense" assumptions that are "taken-for-granted" should be explored systematically and alternative models of public education based on assumptions of cultural pluralism need to be explored. Cross-cultural studies would probably be productive in this area because there are countries, such as Switzerland, which have successfully operated educational systems based on multi-cultural pluralistic assumptions. Such studies would be relevant to learning and behavior problems because they would explore the hypothesis that many learning and behavior problems are now defined are generated by the bureaucratic monocultural nature of educational institutions in the United States.

5. Central to all the above concerns are the methods used to assess learning and behavior problems of children. This paper has attempted to document the following critial needs in the area of assessment:

(1) The need for the development of assessment systems which systematically take the background of the student into account when interpreting the meaning of a particular set of scores on standardized measures. Such a system would differentiate current functioning level from estimated learning potential by identifying as precisely as possible the appropriate normative population for assessing the potential of each student.

(2) The need for the development of assessment instruments which will evaluate the student's performance in non-academic settings, e.g., his social role performance at home and in the community.

(3) The need for the development of screening procedures for identifying those students who may be suffering from biological anomalies which interfere with learning. Such efforts would involve more careful norming of instruments currently being used, such as the Bender-Gestalt, and the development of additional screening measures of the type that can be used in the public schools.

Footnotes

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[2]The sampling frame for each ethnic subsample consisted of 50 cluster of 14 children, 1 male and 1 female at each age level, 5 through 11 years of age. The multi-stage procedure first selected 40 school districts on a probability basis determined by the number of students of a particular ethnic group enrolled in that district. Rural districts with a total enrollment of less than 200 children of a particular ethnic group were combined with other districts to form "contrived" districts. Districts with large enrollment were selected more than once for some samples. For example, the Los Angeles Unified School District, which enrolls over 600,000 students, appeared in the Black sample 19 times, because almost 40% of the Black students in the state are enrolled in that district. It appeared in the Chicano/Latino sample 10 times because approximately 20% of the students from that ethnic category in the state are enrolled in that district. Schools were selected within districts on a probability basis according to the number of students of a particular ethnic group enrolled in the school. Individual children were randomly selected from the attendance records of each school to fill the cluster of 14 children from that school. The ethnic identity of a child was based on his social identity and his surname. The Spanish surnamed children have been designated as Chicano/Latino because that subsample consists of Spanish surnamed children not only from a Mexican heritage but from other Latino cultures, i.e. Cuba, Puerto Rico, Central America and South America.

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THE MUNDANE EXTREME ENVIRONMENT AND ITS EFFECT ON LEARNING

Chester M. Pierce

Introduction

Regrettably the paper must start with an objection. All thinking people must object and should be outraged that at a meeting in 1974 to discuss a research program for the handicapped there is the implication that Blacks in America must be so catalogued. The objection intensifies when it is assumed that in a program of learning disability and behavior problems, Blacks in America (already acknowledged to be a handicapped segment) are lumped into this category.

It may be true that all white and colored poor are indeed handicapped in terms of ability to learn and ability to behave. Yet since such assumptions usually initiate from a white perspective, a Black can argue that Blacks by and large have less trouble learning and less trouble behaving. If this were not true then millions upon millions of Blacks in several generations would not have accepted and accommodated to a disenfranchised citizenship with passive participation in American life.

This objection cannot be stated too vigorously for the perceptual difference between white and Black about such matters as "handicapped", "learning disability" and "behavior problems" will result in quite different opinions relative to basic and applied research that should be spawned and supported by NIE.

In the view of the Black, the problem is not one of learning disability. The *problems* are numerous and diverse. At a minimum they include: 1) Blacks are not permitted to learn 2) Blacks are not thought to be able to learn 3) Blacks are made *unable* to learn 4) Blacks are forced to learn survival lessons that whites are not required to learn.

In terms of this paper the latter two considerations hold most attention since it is the thesis of the report that Blacks, as an urban, segregated people encounter special blocks in learning and co-temporaneously learn to survive because the great bulk of them live under truly harrowing, oppressive, stressful conditions. The only comparable living conditions that approach such extremity are exotic environments where men live under great duress, such as during a space expedition. However, at the outset, let it be clear that in constructing such a theory there can be little doubt that the latency age inhabitant of our inner city is under far greater stress than an adult on a space vehicle. This paper will survey some of the super-abundant data we have on exotic stressful environments and construct hypotheses about life in the mundane stressful environment. From such generalizations will come suggestions relevant to the mission of NIE in educative inquiries.

Parenthetically, it should be stated that although the paper talks of Blacks, most of the material would apply to any human who lives in "ghetto" conditions. In the U.S. of course, this means we are speaking of a disproportionately large number of people who have other than white skin. Also, it should be stated that although the extreme environment usually spoken of is the geographic South Pole, the author is using this reference site as one of several in which he has had direct experience as an investigator. Here too, then, what is said of the South Pole would apply generally to most extreme exotic environments.

Before moving on to a discussion of objectives and definitions, there remains one other matter of moment. In a theoretical paper about learning disability among unfortunate groups, one must remember that the largest problem technically, politically, socially is not learning but both re-learning and unlearning. Despite what discomfort is evoked, government agencies, educational institutions and private citizens must address such awesome facts as the virtual certainty that Black children, like white children, will have to be taught to give up things. The truth is that there is not sufficient replaceable resources on the planet for every person to have as much as the average person has in Harlem. To the man in Harlem what he has is pitiably small compared to the man in Scarsdale. But what the Harlem man has is far in excess of what the average man has in Sisoguichi. Hence, the great problem will be

for citizens to re-learn and un-learn for these pithy, prosaic reasons. Like many events in human nature the fall out may be unexpectedly generous, for what else is a couth and civilized, educated human other than someone who gives over his life to a series of incessant episodes of re-learning and un-learning?

Objectives

The assigned objective is tripartite. Item 1 is to render an interpretation of learning disabilities and behavior problems. As noted, it will be contended that there are environments which probably stay people from learning and which oblige "problem behavior" as a condition of adaptation.

Item 2 requests concern about specific areas in which our knowledge base may be extended. It is submitted that novel and impactful research could be generated by using the available knowledge of extreme exotic environments and applying relevant investigations to the mundane extreme environment.

Item 3 in essence asks for some ideas for basic and applied research. For these purposes a usual operational definition of basic and applied will be employed. Basic research is taken to mean methods of studying underlying processes or mechanisms. Applied research is taken to mean methods of clinical study of particular disorders and their prevention and treatment.

Definitions

Learning Disabilities

The U.S. Office of Education had a committee to formulate a definition of learning disabilities. Kass and Myklebust report this definition as follows:[1]

> "Learning disability refers to one or more significant deficits in essential learning processes requiring special education techniques for remediation.
>
> Children with learning disability generally demonstrate a discrepancy between expected and actual achievement in one or more areas, such as spoken, read or written language, mathematics, and spatial orientation.
>
> The learning disability referred to is not primarily the result of sensory, motor, intellectual or emotional handicap or lack of opportunity to learn.
>
> *Significant deficits* are defined in terms of accepted diagnostic procedures in education and psychology.
>
> *Essential learning processes* are those currently referred to in behavioral science as involving perceptions, integration and expression either verbal or nonverbal.
>
> *Special education techniques for remediation* refers to educational planning based on the diagnostic procedures and results." Everyone will have areas of agreement or disagreement with this definition.

Janet Lerner lists several approaches to learning disabilities. These approaches include brain impairment, uneven growth pattern, difficulty in academic and learning tasks, discrepancy between achievement and potentiality and definition by exclusion.

These etiological theories point up the need for inter-disciplinary investigations while emphasizing the puny and scattered knowledge we now have. Clinically teachers often see the learning disabled as a disruptive class member.[3] Such children do dramatically better if their environment is repatterned and rearranged to reflect order, task orientation and access to materials which are sufficient, diverse and structured. Such children, like astronauts or aquanauts, do better when their goal is defined by a mission and when they know where they can do what. And they do better when they are provided chances for feedback reward. In fine the learning disabled is found in classroom situations which look chaotic and confused. Environmental modification can lead to personality if not character modification.

Behavior Problems

A psychiatrist has no official nomenclature for "behavior problems." As one reads the literature the thought appears that behavior problems may mean simply actions, usually repetitive, which cause distress and dismay to the observer, particularly an adult watching a child from his/her position of authority. Such repetitive actions go the gamut from naughty to nuisance to dangerous and may be disruptive to the attention and goals of other participants in the class.

In situations where teachers therefore believe (no matter how true or necessary such a belief may be) that their chief function is to maintain order while performing a baby sitting chore, it may be that at least some of the classroom disruption is secondary to a failure to be teaching in a way to excite the students' curiosity and to make him/her have more fun learning than obstructing.

Mundane Stressful Environment

The universal attributes of an extreme environment include forced socialization, depression, spatial isolation, time elasticity, biological dysrhythmia, sociological dysrhythmia, increased free time, noise/silence extremes, loneliness, fears of abandonment, anxiety, panic, information fractionalization, boredom and inability to escape. It is axiomatic that the more of these attributes you suffer, the more extreme is your plight. As a corollary axiom it means that the more you are surrounded by these attributes, the greater is your need for courage. And finally it follows as an axiom that the more of these attributes you must mobilize against, the more you are at risk to be overwhelmed by hopelessness.

The inner city resident has more of these attributes to contend with both in quality and quantity. That he survives is a tribute to his learning. That most remain invulnerable to unspeakable distress and hardship - all compounded by racial discrimination and injustice - bespeaks of courage i.e., the ability to act and prevail in the face of insufficient information. The fact that much current data show Blacks with strong self image[4] is indicative of how hopelessness has been tamed. By any definition these are impressive monuments and belie any too ready categorization that a group has troubles learning.

Yet the toll must be terrible and we are yet to prove, although it seems reasonable, that the toll of racism (the chief cause of Blacks being sequestered to the harshness of the mundane stressful environment) literally invites the earlier demise of the inner city inhabitant.

The mundane stressful situation differs from the exotic in many essential regards, which may make it physiologically as well as psychologically a much more grisly experience. It is non-glamorous and there are no rewards for being in it. Risk and violence are commonplace. Subjectively, and perhaps even objectively, its inhabitants are more apt to come to a dangerous end than occupants of exotic extreme environments. Participants in the mundane stressful environment are not selected or trained to work harmoniously and effeciently. Nor is there a clear cut mission, in the mundane setting, whose accomplishment will bring high personal satisfaction, fame or wealth. Thus there are major differences in motivational factors governing individual effort and group relationships.

But the chief difference between inhabitants in mundane and exotic stressful environments is the length of time they stay in the situation. The exotic environment is time limited and the subject realizes that he/she has almost 100% chance of getting out of it. In contrast an inhabitant of the mundane environment recognizes he/she has virtually 100% assurance of remaining in that environment. In addition he/she is not there by choice. And he/she knows that the "outside world" has so little concern about him that rather than mobilizing extraordinary efforts to rescue him, things are done to make sure that he/she remains under mundane stress and that he/she continues to suffer prosaic violence.

The Inability to Learn

Some children, more vulnerable than others, are more susceptible to the devastating effects of life in the extreme mundane environment. In exotic situations such vulnerable participants are de-selected before they go to the hazardous site or they are returned prematurely from the site. Of course, options are not available to the vulnerable, susceptible inner city child. For reasons not yet known, it may be

These time/space considerations oblige the inhabitant to be more than usually conscious of his deference obligations to his peers and to those outside his immediate invironment. Scientists at Plateau Station in Antarctica, a very remote base, by count spent more time out of doors alone than scientists at South Pole Station. One reason for this was that at Plateau, the men were so densely packed and forced into such socialization—yet spatially so remote from those upon whom their existence depended—that the lack of private time/space pushed men out into the hostile elements. The drive for private time/space seems to relate to recognized modification of group goals (thus the goals of the individuall members in contributing to the overall mission). It has been noted that these confined, isolated living arrangements increase the tendency for groups to deteriorate because they lessen the value to cooperate and coordinate.

Some of this alteration in values is related to time useage and time confusion. Even experimentally persons in sensory deprivation have a lowered ability to estimate time. In the Antarctic as in the inner city where there is both sensory deprivation and sensory over-stimulation men often become indifferent, lackadaiscal and uncaring about the passage of time. Under such time inertia the men may attend with much zeal to something other than what they are requested to do e.g., instead of doing any seismography a man might elect to spend large amounts of time with synoptic meterology, even though this is not his field nor what he is being paid to do. Much of this shift in personal interest is enabled because the subjects live with highly variable time schedules with little fixed time obligations (not even meal times have to be at given intervals since men can if they choose eat when they want, with exceedingly less trouble of clashing with social obligations than people could do in less extreme situations).

The time alteration may combine with depression and changing group dynamics to contribute to biorhythm changes. Other contributing components may be sleep variability (socially enhanced and probably biologically originated) and the response to unpredictable and uncontrollable noise; noise is easily heard because the thin walls and overcrowded living is conducive to registering the noise, which is worsened by the unfixed time schedules (studies show that someone is awake and may be moving about at all hours of the twenty-four hour cycle).

All of these environmental factors describe life in the extreme environment with the qualification that they are greater in the inner city and that the factors of worry and concern about existence is greater (for there is no limitless resource like the U.S. Navy poised to rescue one). Finally diet in the inner city is no where as satisfying or as abundant as that of men in polar regions. All these factors may combine to cause sub-clinical biorhythmical alterations.

Our group found that a sleep cycle (hour of retiring) over a one year period described a 28 day periodicity. We found too that the delta rhythm in the brain disappeared from healthy young adults within three months of being at the South Pole and did not return for over a year after the individual had returned to the temperate zone.[5 - 7] Such sub-clinical objective indices may reflect changes that occur in extreme environments that contribute to differences in perception and therefore differences in what is selected as important to learn.

We have found that even prior to entering a hazardous environment, people undergo changes toward depression. It seems as if one's libidinal energy is withdrawn to himself. What is most remarkable about this predictable phenomenon is that behavioral changes are highly apparent to everyone except the man going into the situation. Once into the situation, depression continues due in part to the necessity to be wary for sudden happenings and to be ready to cope with the environment.

There is a need for constant mobilization of energy and surveillance in order to be ready for emergency responsivity. Understandably enough such requirements contribute to a special sort of self concern. The concern for the group is more sharply focussed on how others will behave in terms of allowing the group to persist in crisis. This means other niceties of relationship may be sacrificed. As a result there is social dysrhythm which is aggravated by factors of lower group cohesiveness which are promoted by the biological dysrhythm, time distortions and imprecision about daily schedules.

The lesson seems definitive. If such observations can be made on highly selected trained men in relatively safe circumstances, who remain in such circumstances for a brief period, the possible influences on unselected, untrained people in permanently unsafe circumstances must be devastating. Thus whole

that some exhibit learning disability. Since impairment in this area of functioning makes it more difficult to survive in an already strenuous location, such children indeed might develop "behavior problems". The parallel situation in polar medicine is the man who survives a winter at an isolated base but returns to the temperate zone and seems "zombie like" to friends and relatives. He himself indicates a disinterest and disinclination to study and he doesn't produce on the same plane as he had previously. Usually this difficulty is short lived. Further, those around him realize he can learn but that he is merely not wanting to for a relatively brief period and they usually indulge the behavior. The inner city youth who makes a similar retreat after a much longer acquaintance with stress might be the recipient of such attitudes and pressures by friends, family and teachers that his ability to learn or perhaps more accurately, his willingness to learn is attenuated. Next in the cycle would come "behavior problems", then further hardening of attitudes by significant others, then more unwillingness/inability to learn.

These hypothesized, vulnerable, susceptible youth may have been reduced by a triad of consequences that resulted from the stress of the mundane environment. The triad is: augmented dependency, decreased self confidence and exaggerated deference. The end result of this triad is hopelessness, the chief enemy of those who roam in extreme environments. Overwhelmed by hopelessness the individual has an abbreviated image of himself and demonstrates an indifference to his current and future world. Some in such straits manifest behavior problems as a misguided effort to control their environment as well as to wring help from the environment.

It is not suggested that all people with learning disability, even those in inner cities, exhibit these dynamics. It is suggested that as a research endeavor such subgroups could be sought out since they might prove more amenable to both treatment and prevention techniques.

How does it happen that this hypothetical subgroup evolves? The triad of augmented dependency, decreased self confidence and exaggerated deference is born by overlapping confluences of the universal attributes of life in an extreme environment. Futility is the father to dependency. Imprecision is the father to lower self confidence and exaggerated deference is fathered by time useage.

In the march toward learning most people must prize what there is to learn and will learn what is both fun to learn and what is necessary to learn. For the subpopulation being delineated the triad of obstacles operate to make some types of survival learning so important that there may be little time, desire or need to learn anything else. Thus the concept is not that there is learning disability but that there is inability to make prior the learning that ordinarily defines what educators believe someone should learn. Such individuals may put routine learning on a different or lower scale in the service of maintaining survival. How they accomplish this can be the subject of extensive psychological, sociological and biological investigation. Perhaps the first calls should go to efforts to describe the population and to recognize that the pot pourri of etiological theories may be so structured that many persons erroneously are given a negative label. For a child barely managing to survive his/her extreme environment ot be defined by "exclusion" as learning disabled may be grossly erroneous. No one says scientists in Antarctica are learning disabled because commonly they fail to conduct a planned learning project during their winter in isolation e.g., a man returns home without having taught himself Russian as he vowed he would do. The scientist like the child may have tremendous learning ability but for reasons of environmental duress and other pressing priorities he/she postponed, delayed or cancelled learning something that will be regarded as less than essential. The scientist unlike the child, however, had no continuous and diverse environmental force demanding that he learn and providing sanctions because he didn't learn.

The Origins of Deference

Deference is the behavior which results when the individual expects and accepts that his time can, will and should be controlled, misused or abused. In this definition time and space are coequal. The learning obstacles in extreme environments that mould time/space alternates are forced socialization, depression, spatial isolation, time elasticity, biological dysrhythmia, sociological dysrhythmia and density clustering.

new systems of research can be instituted based on the mountainous research and field experience about how men adjust and adapt to hazardous environments. Further, it means that should a society make the committment such hazardous environments can be diluted and become places of considerable productivity merely by executing plans to help the people in those environments to be contributors.

Just as most people survive the exotic stressful environment, most people survive the mundane stressful environment. Those in either situation who can't or won't learn are somehow de-selected. In the mundane stressful environment, those who are de-selected often are those who are excessively dependent. They feel futile.

The Origin of Futility

In a high altitude desent such as the South Pole, men have much free time, they are subjected to waves of loneliness, fears of abandonment and the knowledge that once the winter sets in there is no escape. Life depends on the support and concern of the outside world. The outside world had to provide stores to let one survive over the winter. The outside world had to reassure that it would see to it that you were returned. Thus when whirling away the abundant, free and unstructured time there is an understanding that the loneliness is temporary and that the world cares enough that you won't be abandoned. Even so the posture of dependency that the man is placed into may be so disabling that he can't learn as well, dosen't want to learn as much and takes much more time to accomplish routine tasks. The little everyday evidence given to men at South Pole that the outside world cares are too enormous to be detailed here.

The paraiiel to the inner city again is definitive. If one is unemployed with certain knowledge that the outside world has abandoned you and will not rescue you, it forces you into the totally dependent position. Then the little, everyday evidences that the world doesn't care also become too enormous to detail here. Yet to sit in a "charity hospital" for six hours awaiting to see a doctor or having a one hour visit by a condescending welfare worker, can allow one to count numerous instances of how the world doesn't care. One can come to feel ambiguous, undefined if he is in the group of vulnerable deselectees. Yet there is still another onslaught to feelings of hope, which is perhaps the ultimate reason to learn. This final onslaught completes the trial of detrimental effects from life in an extreme environment.

The Origin of Imprecision

Time factors and futile feelings are grafted onto feelings of immobility and passivity to erode self confidence. If such erosion remains unchecked then hopelessness, the chief enemy in any extreme environment, takes command. Hopelessness is the final degradation to the concept of self and it is so all consuming that the ability or desire to learn can never be in serious contention. Hence, if environments are found in which hopelessness is clearly in command it would be remarkable to find people able or wanting to study. Yet if they were harassed and threatened even more because of this lack, their behavioral response might look problematical to the person who lived in the camp of hope.

Feeling ambiguous and being imprecise in an extreme environment comes about from the noise/silence extremes, anxiety, panic, information fractionalization and boredom.

Unconcern about time and the amount of free time help constitute the great burden of boredom, so that even highly trained people don't know what to do or are disinclined to do anything. The time and physical inertia is reinforced by the fact that communications to an isolated outpost perforce are delayed, tardy, partial, incomplete or exaggerated. The inhabitants have incomplete data to process. This leads to the danger of reprocessing old or useless data as well as difficulty in making decisions. Thus imprecision becomes rampant. Being removed from the outside world yet totally dependent on its support, the communications barriers promote a hypersuspiciousness and anxiousness that can seem to the outside world to be essentially paranoid. The anxiety relative to these issues can reach panic proportion. In point of etymologic fact there is true "panic" since the word derives from being in the woods so far in the domain of Pan, that you are beyond the reach of the human voice. Objectively being beyond the reach of the human voice is true for men in the South Pole depending on climatic conditions.

At any rate the end result is the same. The inhabitant of the extreme environment may be rendered passive and immobile due to his uncertainty about what, if anything a communication or lack of communication means. He sits tight. If he has a reserve of confidence, bred by previous contacts with the outside world, he will hope that things will turn out alright. If he is bereft of such confidence, then his commander is hopelessness and his fate is beyond attempts to learn.

Suggestions for Research

1. There is a need to institute longitudinal studies on Black children with learning disabilities. These studies should describe the details of the child's environment and his/her parents response to them. The studies should uncover the evolution and natural history of all the various types of learning disabilities. Before dynamic or quantitative studies can be the chief emphasis of research, clearer and more profound descriptions must be obtained. In accomplishing this task the fuzziness of diagnostic concepts will be considered. It may be important to correlate natural evolution of learning disabilities with the development of any physical or mental illness.

2. A host of bio-social investigations could be launched. Among those recommended would be delineating the biorhythmical profile for children with learning disturbances in order to see if they could be taught more effectively at different hours. Telemetered physiological data from home, while the child sleeps, may be very useful in determining whether such children are subjected to subclinical but cumulative changes which influence learning. Also decibel studies of home and immediate environs could be undertaken to see if the group described as learning disabled live in more adverse circumstances or are more readily compromised because of the effect of the environment on certain individual biochemical and physiological processes. These chemical and physiological indicators such as hormones, neurotransmitters, should be looked at in terms of variability related to socio-cultural indicators.

3. Methods should be developed to discover and disseminate to teachers the results of studies to be done on the learning disabled about their use of space and to their need for task orientation and feedback.

4. Since there is some evidence that stress in the exotic environment causes "staring" and "driftiness" and since these novel behaviors can be linked theoretically to TV viewing behavior (and Blacks view more TV) studies should be undertaken to assess the TV habits of children with learning disabilities.[7,8] The types of studies done should look to see if TV can be of an etiological or preventive or treatment consideration in learning disability. The types of studies that would be required could become quite sophisticated. In the Antarctic drifting and staring may be a depressive equivalent which the group permits and which gives a man permission to be away from the group even when there is no privacy. In inner cities there may be similar responsivity and it may take place in connection with TV viewing since this is available, unlike in the Antarctic situation. Children with learning disabilities and thus more lability of attention span might respond differently to TV.

5. Cross cultural studies should be done comparing the learning disabled in descriptive ways and correlating the descriptions with such variables as father's attitude toward learning, mother's expectation, etc. In the Antarctic selection and training can be done with considerable fidelity knowing that subgroups e.g., Navy men versus scientists will have somewhat different adjustment problems to the extreme environment. Hence the cross cultural studies are to look first at sub-cultural groups of Blacks and then other than Black groups. This too would lead to sharpening of diagnosis and more individualized treatment and prevention approaches.

6. Deliberate efforts should be taken to learn if there are special types of subjects or events that are more apt to seize the interest of the child. At the same time ways should be found to make the child know success, recognize his strengths and develop feelings of hopefulness and destine control.

7. Teacher training research could be accomplished with the plan to see if teachers could be drilled concerning how to integrate the learning disabled into his/her peer groups and to have such a student accepted by teacher and fellow students. To accomplish this it would be necessary first to understand more precisely Black group psychodynamics.

8. Related to the need to focus on group dynamic processes is the fact that in extreme environments much predictive benefit has accrued from sociometric and sociogram peer ratings. It is suggested that similar studies on the learning disabled population and their peers should be done, especially if such study looked at perceptual differences in verbal and non verbal communication at a micro-interactional level. Probably much of such studies would have to involve computerization of content analysis after it had been preserved on film or tape.

Conclusion

The obvious conclusion is that the society should move toward eliminating extreme mundane environments. Such a commitment of effort and interest would decrease what is labelled now as learning disabilities amongst the poor. In the meantime using the analogy of extreme environments research can be conducted which embraces all areas of approach suggested in the literature: brain impairment, uneven growth, discrepancy between achievement potential and diagnosis by exclusion.

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THE NEUROLOGICAL ASSESSMENT OF LEARNING DISABILITIES

Rita G. Rudel

Introduction

Any definition of a human condition (let alone of "the human condition") implies some sociological frame of reference. A "disability" is a negative evaluation based on an expectation, and obviously, as one raises or lowers the level of that expectation, one will find more or less "disability." Thus, the expectation that everyone should be able to read, write, and do arithmetic will create more disability in a culture than the acceptance of illiteracy or the non-requirement of reading in a large portion of the population. As the push towards college embraces more and more people, deficiencies have to become more marked, unless one changes the sociological expectation of what a college education involves. The clamor raised recently by reports of rampant reading disability in the schools has raised awareness of the scope of the problem. Few, however, stop to realize that the disability uncovered is based on norms and that these norms define the problem.

Within a particular child, we define "learning disability" as a discrepancy score: how far below grade level is he performing, assuming that his mental age at least closely approximates his chronological age. While this sounds simple enough, there is considerable variation in the level of achievement demanded in different schools or even regions of the country at particular age levels, and one must not lose sight of the fact that "mental age" is not a unitary measure but constructed out of the child's performance on a great variety of tasks which presumably do not (yet) reflect his learning disability. A neurological examination of such a child may then uncover (or fail to uncover) some dysfunction in the nervous system to account for the discrepancy in the child's functioning. Whether or not something is found depends upon the scope of that examination and again, inevitably, the norms against which the neurologist "measures" the child's performance. To quote Denckla: (23)

> "This requires a departure from the usual medical model in which neurologists, like other physicians, have been trained — i.e., that the first medical decision is always sick (abnormal) vs. not sick (normal). In its stead must be a model of age specific (and culture specific) task requirements. Not 'what is wrong with this child?' but 'what are this child's relative strengths and weaknesses?' becomes the central question." (p. 442)

The answer will depend upon where and how the neurologist looks, for an examination even of an adult with specific brain damage which is limited to reflex and motor status can miss an expressive aphasia or alexia. An examination which makes certain "common sense" assumptions about the difference between performance on left and right sides, may overlook subtle deficiencies of lateralization.

The issues to which this paper will address itself may be summarized as follows:

I. Definition and characteristics of early brain damage in terms of

   A. comparison with damage in the adult
   B. The lateralization of function
   C. the genetic evidence in learning disability (is it minimal brain *damage* or minimal brain *difference*?)
   D. the effects of early environmental deprivation

II. Areas of research in Neurology which may be predictive or diagnostic of learning disability.

   A. Attention and hyperactivity
   B. Abnormalities of lateralization (left, right or in between?).
   C. Language development

1.6

I. Definition and characteristics of early brain damage in terms of

A. comparison with damage in the adult

Early brain injury appears to have a severe effect upon certain perceptual and problem-solving tasks in children with (7, 8, 112) or without cerebral palsy (9, 99, 100, 101) when their performance is compared with normal children or with adults who sustained damage after maturity. Contrarily, from some of the animal literature it would appear that brain damage inflicted in the neonate is not nearly as devastating in its effect as damage to the mature animal. This "flexibility" has been shown for lesions inflicted on the motor cortex of monkeys in the early studies of Kennard (60, 61, 62), the visual cortex (31, 113) and auditory cortex (30, 106) of kittens and cats. The studies of Benjamin and Thompson (6) similarly revealed the sparing of sensory function in kittens whose somatosensory cortex was removed compared with adult cats subjected to the same lesions. Thus, Kennard's early evidence that neonatal cortical lesions spares motor function has been confirmed for vision, audition, and somesthesia.

The question, however, remains for more complex tasks where solution in the adult animal appears to depend upon the integrity of the so-called "association cortex". Both Hebb (49) and Russell (103) have suggested that early damage to frontal areas in children might be more disabling than in adults. A study by the author (112) with children suffering from congenital cerebral palsy and compared with an adult population who sustained injury at maturity, suggested that the question of early and late damage had no single answer. Instead, the extent of relative impairment appeared to depend upon the test employed and the age of testing. For, depending upon these conditions, there are effects of damage which (a) appear early and then disappear, (b) are apparent at all ages after early or late lesions, and (3) are apparent only after a delay. In fact, this last aspect of early damage was suggested even in Kennard's work on the motor system, as some of the neonatally damaged monkeys, who appeared to develop normally, developed some spasticity later in life. Lesions of frontal cortex in infant monkeys have revealed similar early, delayed, or permanent effects of lesions. While the infant monkey with bifrontal lobectomy does not develop the delayed-alternation task deficit demonstrated by Jacobsen (1, 57) for the adult monkey with the same lesions, Harlow has shown (43) that response to an "oddities learning set" is impaired with damage inflicted at any age. From developmental studies of Harlow (44, 45) and Kling and Tucker (68, 69), the age at which a function normally appears would seem to be crucial to its recovery after damage. The relative sparing with early damage appears to occur with lesions of the posterior association cortex. The "Kluver-Bucy" syndrome (70) following removals of inferolateral temporal cortex of adult monkeys (80, 81, 94) does not occur following identical removals in the infant monkey brain (91).

The general picture of sparing of function with early damage remains the same for lesions which encroach on the "limbic" structures (67) except for one study by Isaacson et al (56). After bilateral hippocampectomies done in very young kittens, performance on two of three tasks appear unaffected. The third task which requires that the animal delay 10 seconds after each bar press is as sensitive to early lesions as to those inflicted on a mature animal. The recent work of Patricia Goldman (40, 41, 42) points as well to deficits on complex functions following early lesions. Few animal studies have invaded subcortical structures in the search for effects of early damage, although precisely these are likely to be involved in congenital or prenatal injuries. A combined frontalcaudate lesion, inflicted in the neonatal monkey, does abolish delayed-response capacity entirely, according to a study by Kling and Tucker (68, 69). Further, animals with such lesions were hyperactive and unmanageable. Hyperactivity has long been known as a consequence of caudate lesions in adult monkeys (20) but its delayed onset after early lesions is of considerable interest since it provides a parallel to clinical phenomena seen after early head injury in children (10). Children with congenital absence of interhemispheric commissures do not exhibit anything like the severe disconnection syndromes that one often sees after surgical disconnection in the adult (59, 108). Still, one suspects certain other losses. These children display preponderantly low intelligence quotients. Thus, while early absence of commissures might interfere less than later transection with information flow between the hemispheres, it might carry another penalty manifested in a general reduction of intelligence.

In the same way, recovery from aphasia in children and even the lack of aphasia in children with congenital right hemiparesis does not mean an absence of symptoms even in the language area. Milner's findings (79) in this regard (1968) are particularly relevant: Language did not develop in the right hemisphere unless the early lesion in the left encroached upon the language zones. Again, the average intelligence quotients in those patients whose speech developed definitely in the right hemisphere was rather low, suggesting that the sparing of expressive language with early lesion to a dominant lobe might have been achieved at a price.

The developing animal or human brain appears to have considerable flexibility so that with early damage there is sparing of functions, notably those involving the sensory systems (101). Thus, sensory deficits of 2-point discrimination, position sense, or localization with double simultaneous stimulation are characteristic only of retarded Ss where one is uncertain whether instructions are understood or attention to the task maintained (102).

The concentration of deficits on the more complex tasks is reminiscent of a suggestion made long ago by Vygotski (117) that early injuries of the brain tend to leave elementary functions relatively intact while precluding or impairing the development of more complex aspects of performance. In a relatively unselected series of adults with injuries sustained at maturity, elementary sensory defects were considerably more frequent and impaired performance on more complex perceptual tasks was rarely found in the absence of elementary sensory deficits (105). Unlike brain-injured adults, children have deficits of discrimination without deficits of detection.

A recent study by Boll and Reitan (11) of a wide range of functions in brain-injured children, concludes that early and late damage are not comparable since test scores in the adult correlate with each other whereas they do not in the child. Such a lack of correlation may be the statistical expression of precisely such sparing of elementary functions in the child at the expense of those which are more complex.

A neurological diagnosis is virtually a summary of the motor and reflex anomolies. Even in those brain damaged children who seem to be totally ambulatory and to have complete use of their hands, the motor system is not spared, with occasional involvement of the oculomotor system and impairment of coordinated function of the extremities. It has been demonstrated (99) that tasks involving spatial orientation and discrimination of geometric forms are particularly vulnerable in children with oculomotor disturbances. Arguing against a mere association of symptoms in these children is the fact that the oculomotor disturbance did not selectively impair the performance of these children on a body scheme task which does not involve visual search, perception of contours, or spatial coordinates (nor were they dyslexic). The dissociation of performance on tasks of personal and extra-personal space occurred also in adults with brain injury (104).

Paradoxically, with early damage, the "flexibility" of the developing brain tends to spare the most elementary functions at the expense of more complex functions. One would not, therefore, expect to find elevated touch or auditory thresholds as concommitants of poor object recognition or speech comprehension. Quite the contrary, there is some indication that early brain damage may produce exquisitely fine touch sensitivity (102) and *hyper*acusis may accompany some dysphasias (22). The visual fields of children with perceptual problems are almost always normal (101) and the ability to speak is rarely the problem in children with language disturbance. The effect of early damage, then, in relation to late damage is rather as pastels are to vivid colors. Especially on more elementary levels, symptoms are not as dramatic or severe but become increasingly apparent as more complex coordinations are expected of the child. It is at that more complex level that symptom associations and dissociations appear to be organized in children as they are in adults whose damage was sustained at maturity. The WAIS profile of an adult rendered dyslexic by neurosurgical intervention (26) is identical to the WISC profile reported for many children with developmental dyslexia (111). Adult dyslexic patients and our young developmental dyslexics perform quite normally on a spatial orientation test (97), while they name objects repetitively much more slowly than normal (28). Possibly due to the normal development of relatively simple functions, many of these children are not suspected of being "deficient" until school age and only then, retrospectively, do parents "remember" earlier symptoms. Specific localization or etiology of injury is, of course, not available for most cases of early damage except that inferences may sometimes be drawn for lateralization of functions on the basis of neurological examination.

It should be stressed that the relating of early, presumed sub-cortical damage to cortical damage sustained at maturity should help define deficits in terms of functional systems. This approach is a possible biological alternative to factor analysis.

B. The lateralization of function

The greater asymmetry of function in the human brain provides comparisons of lateralization effects in normal and abnormal development. The issue of lateralized preference or skill in the learning disabled child presents us with something of an enigma. More than 35 years ago, Orton (1937) called attention to the fact that a high proportion of children with higher nervous system dysfunctions showed weak or late lateralization of hand preference, and he saw this as a reflection of anomolous cerebral dominance (86, 55). Indeed, an excess of mixed-handers and left-handers characterize the lower IQ levels, and among children with minimal brain damage, one finds a significant percentage who use either hand and show mixed lateral preference combinations of hand, foot, or eye, often called mixed-dominance. Most of these children are bilaterally clumsy (or ambisinistrous rather than ambidextrous) (20). At least as commonly, one sees right-preferring learning-disabled children with inadequate left-hand performance. Reitan has reported that certain brain-damaged children show a greater magnitude of preferred-hand superiority in handwriting than do normals (93). Inadequate left-hand scores for speed and skill have been shown by Annett (4a) to be correlated with lower vocabulary scores. That the left hand score is frequently affected by early brain damage has been recently reported (101). If, then there are learning disabled children who are insufficiently lateralized, there must be others who are hyperlateralized.

To add to the enigma of lateralization, there are reports that left-handed Ss preponderantly populate both ends of the IQ spectrum, at the very low and very high IQ levels (4). More than 20% of the entering class at M.I.T. write with their left hands. The resolution of this paradox might not only clarify the lateralization problem but significantly add to our understanding of a variety of manifestations of the functional asymmetry of the brain. However, its resolution must lie in more than a single direction.

1. Effects of early brain damage on cerebral dominance:

Some lateralized brain damage may be at the core of developmental disturbances of left and right-sided skills. One could expect, even short of hemiplegia, that some lateralized dysfunction might lead to a shift of performance to the other side. However, a recent study (101) showed that while 20% of a group of brain damaged children were relatively more impaired on their right side (with presumed left hemisphere damage), only 10% of the total population were left-handed. Thus, not much shift appears to occur, for as noted, it is only at the low end of the IQ scale (heavily loaded with brain damaged individuals) that a shift toward left-handedness occurs out of proportion to the general population.

In 1961 McFie reported that, on the whole, Wechsler subtest results were in the same direction in brain-damaged children as in adults (76); there was a tendency for verbal impairment to be associated with left and performance impairment to be associated with right hemisphere lesions. In a recent study of 292 children with learning disabilities, we have obtained strikingly similar results (96).

That there is some relatedness of perceptual deficits to lateralization of neurological symptoms in the child was further reinforced by results of haptic object recognition and route-finding tasks, both of which are associated in the adult with damage to the right hemisphere. Performance on both was more impaired in children with predominantly left-sided impairment (presumed greater right-hemisphere damage) in spite of their intellectual superiority (according to the WISC) to the group with right-sided impairment (101).

Children with right-sided, presumed left-hemisphere, impairment had shorter temporal spans in repeating digits forward. The ability to repeat them as given was relatively less impaired in those with left sided signs (presumed right-hemisphere damage), but they had more difficulty with digits backward, a task that would appear to depend upon "spatializing" the series for "reading" backward (96). Similar results were recently obtained with hemiplegic adults (118).

However, it should be noted that in these studies, the children with predominantly right-sided damage were not overtly aphasic, unlike adults with left-hemisphere damage sustained at maturity, although many had language disturbances. They do more poorly on tests largely dependent upon language, e.g., a body scheme test which requires naming of body parts (101), a test of rapid repetitive naming (28) and on the Oldfield Naming test, but there is obviously an attentuation of the symptoms compared with those associated with late damage. This could mean that the adult pattern is not as fully expressed in the very young or that basic speech, like sensory input, is spared with early damage, relative to later developing cognitive and spatial skills (120). Milner (78) has reported that language does not "shift" to the right hemisphere after very early brain damage unless the lesions in the left hemisphere are extensive enough and placed in such a fashion that they encroach on a major portion of the classical language zone.

2. Effects of left-handedness on cerebral organization:

It is known from the work of Hecaen (50) that the language area is likely to be on the left or ambilateral in left-handed people and only very rarely on the right. The work of Annett (4a) has stressed the genetic factors and the complexity of relating performance to these factors. Data on tool use in sinistral Ss suggests less asymmetry of skill than prevails in the dextral population (7). It is apparent from the normal prevalence of left-handedness (10%) among intelligent children with learning disabilities, some of whom have brain damage, how strong is the genetic (and perhaps environmental) compulsion to right-handedness. Therefore, one must contront left-handedness as sometimes a pathological phenomenon but more often as a genetic alteration which organizes hemispheric specialization differently, either to the detriment or occasionally to the advantage of the left-handed individual.

Whatever else may happen with early brain damage, the asymmetry of lateralized hemispheric function remains relatively unaffected so that inferences from normative studies and studies of alteration of function with late damage can be made.

C. The Genetic Evidence in Learning Disability

The recent report of Symmes and Rapaport (111) has focussed attention on the possibility that dyslexia is an inherited "disability," a male sexlinked, recessive characteristic which affects short-term language storage. These authors insist that dyslexia in girls, which is much rarer, is caused by perceptual, emotional, or intellectual dfficulties. The boys they studied had no neurological "signs" and were of normal intelligence, but their three poorest scores on the WISC were Arithmetic, Digit Span, and Coding, three tasks requiring serial ordering and short-term retention. At the same time they were very superior on tasks requiring three-dimensional perception, and the authors conclude that this right-hemisphere task superiority is as "aberrant" as their reading disability.

We have, so far, been unable to find many comparable cases of developmental dyslexia; those we have found do have "soft" neurological signs but then that discrepancy may be due to differences in the examinations rather than to differences in the sample. There is no reason to reject the hypothesis that minor neurological deviations from the norm (primarily differences in levels of left-right functioning) as well as the dyslexia are due to genetic differences. The geneticist, Barton Childs, (16) has approached the problem more directly by requiring the parents of dyslexic and non-dyslexic children to read under difficult conditions, e.g., to read print reflected in a mirror. It is strenuous, but apparently most people "get the hang" of it very quickly and do well. Preliminary results indicate that at least one parent of a dyslexic child is more likely not to be able to read under this added pressure than is the parent of a non-dyslexic control.

The siblings of dyslexic children are more likely to have spelling difficulties than the siblings of non-dyslexics, according to a rather exhaustive study recently done in Palo Alto (88).

The evidence is still coming in to support the contention that occasionally learning disabilities are inherited, a possibility long suspected by some parents who recognize in their children difficulties they themselves experienced in more attenuated form. It is probable that some of the "minimal brain damage" which has been invoked to explain certain minimal brain dysfunction may be genetic minimal brain differences.

D. The Effects of Early Environmental Deprivation

Since the work of Harlow and others on animal rearing in "enriched" vs. "deprived" environments, the cultural deprivation analogue for neurological deficit has been part of our working consciousness (and perhaps conscience). The continuing exploration of these questions by Held (52,53) and of research on effects of isolation rearing has made us aware of the importance of critical periods for the use of particular faculties and the disastrous effects of disuse. It is rare that one can document a case of extreme deprivation, but there has been a recent series of papers (35, 72, 73) describing a single case of almost total neglect: the case of Genie, a girl found at 13 years 9 months. She had been tied to a potty chair or to a bed, fed nothing but baby foods, and beaten whenever she uttered a sound. Early medical records reveal no trace of retardation nor was there evidence of any "neurological disease" when she was found, although she was unable to speak. She has been learning language now for almost three years, in spite of the fact that she was found after the critical period for speech development. However, her language capacity appears to be limited and from tests of dichotic listening, she is apparently utilizing the contralateral connections between her right hemisphere and left ear for speech processing as well as for identifying environmental sounds. Her right hemisphere "is doing all the work" (p. 98) (35), indicating that her extreme deprivation through the critical periods for acquiring language effectively produced a left hemispherectomy, a kind of "functional atrophy of the usual language centers." (p. 101) (35)

Such extreme, brutal neglect is, fortunately, rarely encountered. However, in varying degrees it is possible that children left alone for long periods of time or not spoken to very frequently may suffer enough "functional atrophy" to preclude proper activation of developing neuronal connections.

Poor nutrition during the early months of life appears also to be involved in the "deprivation" analogue, and only recently have studies begun into the effects of drugs on foetal development. Whatever we call these effects, however, whether they are attributed to nature or nurture, the alterations they produce on the nervous system will permanently impair the developing organism.

II Areas of Research in Neurology

A. Attention and Hyperactivity

Probably the most common cause for referral of a child for study by a neurologist or psychologist is inattentiveness or hyperactivity. While one is more likely to encounter a child who flits from one thing to another and is unable to sit still, the problem is just as acute, if less troublesome, with the one who pays little heed to what goes on around him. The first appears to be driven by every stimulus in his environment, the second seems to notice little and retain less. The hyperkinetic child, of course, tends to be brought for professional attention sooner by despairing parents or teachers and the justification for medication has been questioned. Obviously, the criteria for the designation "hyperactive" need to be examined; a demanding disciplinarian may have a very different threshold of despair than the parent who practices benign neglect and is not around very much. Even in professional journals, however, the criteria "for lumping 'hyperactive' children together leaves one uncomfortable," according to Denckla (23) and that author offers the following checklist for hyperkinetic behavior, indicating that the first four are most important, the remaining three are next most common:

1. Overactive (or restless, unusually energetic)
2. Distractible (or short attention span, not finishing schoolwork)
3. Hard to discipline (home and school)
4. Silly, immature
5. Doesn't follow directions
6. Easily upset
7. Discipline problems at school only

Contrasted with

"Acting-Out" cluster

- Lies
- Steals
- Sets fires

Destructive
Bad language

Hypokinesis—withdrawal cluster
Lethargic (sits or lies around)
Lack of interests or hobbies (apathetic)
withdraws from peers
withdraws from adults

Schizoid Cluster
Withdraws from peers
Withdraws from adults
Does same thing over and over
Insists on routines
Upset if environment or routine changes
Fears many things

The commonness of hyperactivity reflects the "multiple sites in the nervous system at which the arousal-alerting-inhibiting systems (the core of the neuraxis) can be impaired. All goal oriented behavior can be 'diffusely' disrupted by such disorders, but the lesion (anatomic, physiological, or chemical) may *not* be diffuse." (35, p. 446)

Psychometrics have been shown by Douglas (32) to be inadequate for differentiating between controls and hyperactive children and not useful for evaluating the effects on them of medication, since IQ is enhanced by use of stimulants by either group. Tasks differentiating hyperkinetics from controls involve speed of reaction, vigilance, continuous performance, and ability to delay response and plan. The following are suggested:

1. The Face-Hand test or double-simultaneous stimulation: This is a common neurological test of the ability to identify two homologous or heterologous, ipsilateral or contralateral contacts. Attention is vital and extinction or displacement of one of the "touches" has a definite maturaltional age limit.

2. Test of reaction time to 1) visual and 2) auditory signals. The use of a variable pre-signal period tests the child's ability not to "jump the gun." Auditory signals can be delivered monaurally with and without the child's knowledge of which ear is being stimulated. According to results by Simon (107) and Haydon and Spellacy (47) with adults, direction of attention to the source of the sound equalizes any difference between the two ears. It remains to be seen whether children are capable of such attentional change and whether hyperkinetic children would differ in this capacity.

3. Tracking tests which require hand eye coordination test the child's ability to remain on target. Deviations from normal have been found on this test in adults with sub-cortical lesions (12).

4. Digits repeated forward and back are part of the WISC but norms need to be referenced separately for the two parts of the test (96).

5. Tests to tap vigilance for letters, numbers, words, and geometric forms are being developed and speed of performance can be evaluated in the light of simple reaction time and motor tracking tests.

6. The Digit Symbol task of the WISC, another timed test. Taken together, each child's performance can be evaluated in terms of the generality of specificity of the slowing down; right or left, symbols vs. letters, perception vs. reproduction of symbols.

Eventually, research into the problem will have to include electroencephalography, galvanic skin responses, pupillary reactions, and measurement of heart rate. A recent study (115) has in fact provided norms at ages 6 and 10 for three components of attention on heart rate, striate muscle activity, and respiration. Two of the situations required orientation towards the environment and a third internal attention (remembering). Whether the task was visual or auditory, orientation led to cardiac decelaration and internal

attention to acceleration with concommitant predictable muscle changes. Such studies must be undertaken with children who appear not to "attend" out of hyperkinesis or placidity, to determine whether their somatic activity also differs from the norm in a variety of situations. The results may lead to 1) establishment of conditions which call for medication and 2) a means for determining the effect of treatment. Aside from such more medically oriented goals, studies of this type on a broad range of the beginning school population would help in prognostic evaluations and perhaps early remediation.

One of the areas not covered under "attention" in this section is the relative efficiency of left and right hands, ears, eyes, or visual fields. Denckla (23) has found that one of the frequent concommitants of hyperkinesis is a larger than normal difference score in timed performance of the left and right sides, with the left usually lagging behind. A study by Knights and Hinton (71) has shown that the administration of Ritalin (Methyl-Phenidate) to hyperkinetic children resulted in a significant improvement of their non-dominant hand on pegboard performance. Since lateralization studies in the broader context of learning disabilities will be taken up in IIB, it should be borne in mind that many of them would be equally relevant to studies of the hyperkinetic or otherwise inattentive child.

B. Abnormalities of Lateralization

In our assessment of the characteristics of children with early brain damage, we noted the paradox inherent in various reports, i.e. that these Ss are overlateralized (much better with preferred at the expense of the non-preferred side) or that they are underlateralized (somewhat ambilaterally equal in performance). It is possible that this is due to the confussion inherent in the term "lateralization," depending upon whether one refers to preference, speed, or skill. Before attempting to delineate the research needed in this area, it may be useful to review the findings in relation to normal children and adults. How right-handed, footed, eyed, or eared is the right-preferring person?

Annett (4a) has reviewed the evidence that on various tasks the distribution of lateral preference is quite different from the distribution of right vs. left sided skill. In a recent study (21) 30% of right-foot-preferring children (5-6 years old) hopped and balanced better on the left foot. Not all right-eye preferring adults use the right eye with greater speed (82) and Braille is read more accurately by the left hand of right handed blind (54) as well as sighted Ss (98). The age specific distribution of right-left differences in various motor skills may turn out to be a more important aspect of "lateralization" both diagnostically and theoretically than are distributions of preference for handedness, eyedness, or footedness. Underlying most standard tests of laterality (19, 46, 24) is the presumption that the more "skilled" hand will wield the tool: with which hand do you write, sew, hammer, comb your hair, hold a bat or a violin bow? Confirming "common sense" expectations for the preferred hand in normal children are studies by Reitan (93) for handwriting skill and by Zurif and Carson (122) for cutting circles with scissors. Greater proficiency of the normal right hand is reported in a study of pursuit of an illuminated roter circular path, using a probe (48) but equal proficiency is reported of normal right-handers and left-handers in tracking a light moving at random on a screen, using the index finger (12)

The right-hand is apparently extremely specialized for tool use and in this sense may provide a very special link to the left hemisphere.

However even with this one source of firm evidence for right-hand superiority, one has to deal with the fact that tools invariably require visual guidance (3). There is some confirmation of just such dependence. Gardner (36) reported that vision tended to equalize the performance of the two hands on a form-board task better performed (by right-handed adults) with the left hand while, complimentarily, Buffrey (14) has demonstrated that, using pencils, young children could draw simple geometric forms equally well with both hands if vision were excluded. Touch typists were faster with their left hands in controlled tests while beginners who have to look at the keys, were better with their right (90).

Putting the evidence together, it appears that motor skills involving strength, repetitive speed, and tool use tend to be performed better by the right side (110, 119, 121, 12, 92, 4a, 64, 15) whereas motor skills involving spatially accurate placements, tactual or visual, whether speed is involved or not, tend to be performed equally well or better by the left side of right-preferring Ss (32, 12, 116, 65, 66). Furthermore, on some tasks, sex differences in relative lateral skill of right-preferring children and adults have been reported (36, 4a, 63, 24). These functional asymmetries of skill in right-preferring Ss are of interest in terms of

their implications for understanding the relative contributions of each cerebral hemisphere to motor control of each side of the body under various task-dependent constraints.

From the work of Annett (4a), Touwen and Prechtl (113) and Denckla (21, 24) it would appear that in right-preferring children motor skills develop first on the right side followed by a rapid increase in left-sided function so that by age 7 years, although the right preferring population preforms somewhat better on the right side, there is a very small mean right superiority within individuals. This difference remains larger in some learning disabled children (92, 27).

The neural mechanisms underlying this developmental pattern may be 1) right hemisphere itself developing; 2) the interhemispheric connections developing such that the left hemisphere truly "dominates" motor output of the right; and 3) the ipsilateral pathways of the left hemisphere developing so that the left hemisphere controls motor output of both sides (55, 24, 21) At present there is insufficient evidence to allow a choice among these possibilities; perhaps all three are operative. The second (maturation of interhemispheric connections) is appealing because it fits classical notions of left-sided motor skill control, derived from studies of apraxia (109, 37, 51); and the report that in contrast to the closely similar tapping rates, right and left, of normal adult subjects, commissurotomy patients' left intertap interval was 40-70 msec. longer than their right (74). Recently, moreover, preliminary findings implicating faulty interhemispheric integration in children with developmental dyslexia have emerged from EEG and perceptual-motor studies (95, 96). If confirmed, such indications of delayed neurophysiological connections would be yet other ways in which learning-disabled children resemble younger-normal children (66).

It would seem that the most fruitful manner in which to proceed on this complex issue is to determine the left and right preference and skill of hand, foot, eye, ear and visual field in children with learning disability as well as comparable controls in a range of ages.

1. Tests for lateralized preference:

There are many batteries for determining preference for hand and foot (19,21, 24, 46); eye acuity can be determined with Snellen chart with S allowed to wear glasses, and sighting preference with the Miles ABC Vision Test (77). Relative ear acuity can be determined prior to any auditory testing. Finally, all children, whether right or left handed should be given a questionnaire to take home on the handedness of their immediate family members in order to provide information on genetic factors in their lateralization. Perhaps the "familial" left-hander has much more in common with the right-hander with a left-handed parent than we now realize. These "preference" considerations are important for whatever they may mean, they are related to language, if not causally at least concommitantly. Left-handedness is *not* more common in children with language disorders than in the general population but poorly defined handedness and crossed or mixed hand-foot- eye combinations are observed more commonly.

A recent study showed more relationship between eye preference and language perception in the right visual field than handedness and that same variable (13).

2. Tests of Speed and Skill: Hand and Foot

Finger tapping (forefinger against thumb), fingers in serial opposition to the thumb, pronation and supination of the hands, hand tapping, feet tapping, and heel-toe alternation, are the rapid repetitive, successive and alternating movements common to the neurological examination. Denckla (24) has developed norms for right-handed Ss on activities in terms of "time to do twenty movements" and this quantified traditional neurological examination has yielded data of significance for theories of development of relative lateral skill. Additionally, there are norms for hopping and balancing on one foot (21) to the child's maximum within a fixed-ceiling limit. The technique holds promise as a prognostic and diagnostic indicator in development, particularly when the norms are broadened to include children from wider socio-economic range and to include left-handed Ss as well as right. Since the left-hand population appears to be preponderantly represented at the two extremes of the IQ range, it would appear to be important to determine whether lateralization differences in these extreme groups might suggest alternative organizations of cerebral hemispheric asymmetry. This quantified neurological examination may provide a good point of departure.

The use of tools appears to increase the superiority of the preferred hand while the exclusion of vision tends to equalize the hands. It is suggested, therefore, that the relative efficiency of the two hands be tested for skill in a variety of situations:

a. Drawing simple geometric forms with index finger dipped in finger paint contrasted with the same drawings made by left and right hands holding a brush.

b. Tapping tests, tracking tests to be performed with and without tools.

c. Tapping tests to be performed with the hand (or foot) hidden from view.

d. Drawing with left and right hands separately, as well as together (cf. Buffery, 14) but with vision excluded.

e. Pegboard performance of left and right hands with and without visual guidance.

The extent to which one can "force" changes in lateral differences under such a variety of conditions may explicate the processes involved and perhaps lead to a clearer concept of what "overlateralized" or "ambilateral" might mean.

3. Tests of Speed and Skill: the eye and the visual field

While "eye preference" is almost always discussed in terms of sighting preference, the speed of movement of the eye to a target may be different for the two sides and may involve a form of "dominance" that is more relevant to perception than is sighting. Methods are available to do this, and in fact, there is evidence (82) that one eye leads in tachistoscopic recognition of letters. There is a small but consistent difference between the eyes in normal adults, but should this difference between left and right be greater in learning disabled children, it might account for some line following difficulties. Since a greater than normal difference between the performance of the two hands of these children has been reported (92, 27), such a finding for the eyes is not impossible.

Similarly, the speed of reaction to the appearance of a stimulus in the visual field might be faster in one side than the other, reflecting possibly the "pace-setting" function of the left hemisphere. One would expect, therefore, that reaction to the appearance (or disappearance) of a stimulus in the right visual field should be faster than in the left visual field. The specificity of reaction to language or non-language materials should develop over and above this in the right and left visual fields respectively. The difference between response to left and right fields in normal children and in children with learning disabilities needs to be assessed with the simple reaction time established initially.

There have been no (known to this author) tests of learning in the left and right visual fields while there have been demonstrations of specialization of the hemispheres to language and non-language material. The paired-associates method lends itself naturally to material flashed to one field or the other while the child maintains fixation. It has already been demonstrated that Braille is learned better by the left hand than the right (by right-handed, sighted children), but this unexpected superiority needs to be tested in learning disabled children. It would be a simple matter to turn the Braille figures into visual configurations for learning in the left or right visual field. Again, the amount of difference between the two sides might reveal something about the nature of hemispheric specialization in learning and the alterations with early brain damage or difference. By shifting the relative difficulty of the tasks, one could shift the burden from one hemisphere to the other, e.g., by increasing the difficulty of the language association to the Braille configuration, one might shift the relative superiority of left and right sides. One might accomplish the opposite by increasing the difficulty of the configuration and decreasing the difficulty of the language response. Such "weighted" experiments might focus on specific disabilities, particularly in relation to the lateralization of defect and hemispheric interaction.

4. Tests of Speed and Skill: the ear

The right ear is faster to respond in the normal adult (107) and more "set" to respond to sound (47). Yet, when S knows his left ear is to be stimulated, he responds as rapidly as with right ear stimulation, indicating some "instruction" of the right hemisphere which must involve interhemispheric interaction. When this capacity is developed is unknown nor is it known whether the learning disabled child (with or without demonstrable brain damage) is able to make this adjustment of the left ear so that it equals the right in speed of performance.

It has been demonstrated (75) that lateralized damage in the adult alters the perception of simultaneity when clicks are delivered to the two ears. This phenomenon not only needs to be examined developmentally but may be useful for determining the presence of lateralized damage in the child.

Learning can be tested for each ear separately to determine relative speed and efficiency in hemispheric functioning. Serial analogues of the Braille study can be useful not only for determining lateralized auditory functioning but for defining the modality specificity of learning disabilities.

5. Prognostic Use of Tests of Lateralization

The consistency or lack of consistency of left-right performance through the series of tests and with the preference inventories would provide preliminary evidence on the consistency of dominance in children, with or without learning disabilities over a broad age range. The need for developmental norms in all these areas provides an opportunity for signalling attention to children whose performance appears to be aberrant. The measurements available would be along any of these dimensions: a) the absolute performance of the right (or dominant) side, b) the absolute performance of the left side, and c) the difference between them. Thus, the right side score may be within the normal range but the difference score may be large by virtue of the poor performance of the left; the difference score may be normal by virtue of the poor performance on the right, etc. A further indicator of possible pathology are ipsi or contralateral synkinesiae during performance of the motor tasks, beyond the age of 9 or 10 years.

6. Diagnostic use of Tests of Laterlization

The technique outlined above, in conjunction with lateralization of "signs" in the tests taken from the neurological examination, should provide adequate information for delineating the nature of any deficits. The broad base of norms will provide reference points on each phase of the evaluation and help answer some of the following questions:

a. What shifts in normal lateralization occur with early brain damage with left, right, or bilateral signs?

b. What alteration of function takes place as a result of such shifts?

c. Do visual and auditory lateralizations develop normally and independently of alterations in the lateralization of motor performance by the limbs?

d. Are these shifts modality-specific? e.g., might the visual left-right tasks be impaired while the auditory left-right tasks are spared?

e. Can the modality-specificity issue by better resolved in terms of spatial vs. sequential functions? If auditory lateralization appears to be abnormal while visual lateralization appears to be unaffected, could it be a result of the serial nature of the auditory tasks? Would serial visual tasks be equally affected?

Is the learning disabled child without signs of brain damage

i. Is development of lateralization in hand, foot, ear, eye and visual field the same for these children as for the normal child of his age and sex, or his there a lag? Does he appear like a younger normal child? (Kinsbourne, 66).

ii. Is there an age limit for such a lag, e.g. does one find many such younger-appearing learning disabled children at age 8 but rarely at age 12?

iii. In contrast, are there learning disabled children who never catch up, i.e., may the difference between left and right or poorer performance on both sides remain?

iv. As with the brain-damaged, may there be disabilities in one system while the others are spared?

v. Are deviations from the norm more identifiable by modality (i.e., audition or vision) or function (simultaneous or serial)?

vi. Are there differences between the learning disabled child and the controls which suggest neither left nor right-sided damage but rather difficulties with inter-hemispheric connections?

vii. Are there learning disabled Ss who are indistinguishable from controls on all these tests of lateralization?

These questions answered in the light of the child's academic performance and the studies of attention (section A) ought to then be studied in conjunction with tests of language (section C). Insofar as lateralized impairments are pinpointed and they coincide with deficits in adults with localizable lesions or with partial commissurotomies, we may be in a position to hypothesize localization of damage in the child, if not topographically, at least in terms of functional systems.

C. Language Development

The effects of early hemispherectomy are described elsewhere (5) and as has been indicated above, although early damage of the left hemisphere does not preclude speech, the child does not develop without language problems. All the evidence points to limitations in use of language with early damage and concommitant intellectual deficits not necessarily restricted to language tasks. Woods and Teuber (120) have shown that when speech develops in the right hemisphere it does so at the expense of those functions (spatial, configurational) which usually develop on that side.

While there are occasional anecdotal reports of geniuses who did not speak until the age of three, delayed language acquisition is usually associated with subsequent deficits. The high correlation of dyslexia with a history of late or defective speech has been well documented (55). A timetable of speech development as well as a description of the most common disorders is offered by Denckla (22) and will not be reviewed here. The search for understanding of developmental dyslexia has recently been leading away from visual-perceptual and toward auditory-linguistic factors. Critchley 1970, reviewing the history of developmental dyslexia ahs placed the problem squarely in an "aphaseological context" (18). Therefore, this section will stress needed language research for the most prevalent learning disability: dyslexia. It will, of necessity, be based partly on research with adults who become aphasic or alexic as a result of brain injury. Geschwind (38) suggested in 1962 that reading disorders ought to be studied in the light of clues provided by the shared dysfunction of acquired and developmental dyslexia. To quote Denckla: (22)

> ". . .one cannot afford to throw away analogies between language dysfunctions that establish links between childhood developmental and adult acquired syndromes. At stake are the practical quest for effective therapeutic strategies and the intellectual quest for understanding of the human brain." (p. 303)

1. Language on standard psychometric tests

Correlations between IQ scores on WISC or Stanford-Binet and reading ability are almost by definition very poor, indeed, the definition of dyslexia reflects the discrepancy between mental age and reading age. The WISC language scores in themselves are also rarely predictive or indicative of reading difficulty, and if one examines the nature of those sub-tests, one thing becomes clear. The language tests are a) untimed except for arithmetic (which correlates with performance scores) and b) rarely call for one-word-specificity in naming, except for a few items on "information". The rest is a matter of defining, classifying or explaining, all situations allowing for considerable circumlocution and all the time the child needs.

The interesting finding of Symmes and Rapaport (111) of a consistent WISC profile in dyslexic boys only confirms the importance of timing: They all did most poorly on coding, arithmetic (both timed tests) and digit span which intrinsically requires the most rapid possible response. A patient with acquired dyslexia (a 30-year old male) had the identical WISC profile (26).

Neither the Stanford-Binet nor the Peabody tests require "naming" or report latencies of response. A vital need, then, is for timed tests of language, particularly of naming.

2. Studies of latency in naming

There have been many studies showing a difficulty in naming, particularly of colors and letters in adults with acquired alexia (Geschwind and Frisillo, 39) and Denckla has shown the color-naming deficit in dyslexic boys (26). Naming tests have been highly predictive of which kindergarten children are most likely to fail in reading (58) and Eakin and Douglas (33) have studied naming under the additional

stress of timing where "automatization" is required. They found that, in contrast to tests of block design, mazes, and embedded figures, only on the "automatized" naming tasks were poor readers significantly inferior to controls.

We have developed a timed naming test (29) (colors, objects, letters, numbers) and established norms for age 5-10:11. Recent, still unreported, studies (28) demonstrate the relative slowness of dyslexic children on these tasks, particularly on colors and objects, names which are acquired long before numbers or letters. Continued research is required particularly in a broader socio-economic range and the usefulness of the test for reading prognosis remains to be determined.

The naming test of Oldfield (85) was developed for work with adult aphasics: the resemblance of dyslexic children to adult aphasics (84) on this task is striking and quite different from the performance of non-dyslexic brain-damaged children or demented adults. This line of research needs to be pursued with words in a variety of frequency categories (Lorge-Thorndike) for more disadvanted populations. The prognostic value of such a test is unknown.

3. Tests of association:

If, indeed, dyslexia has an "anomic" quality as determined by naming tests, it would be important to learn how the *acquisition* of names by these children differs from the same process in non-dyslexic children.

a. Analogies of types of errors made by dyslexic children on tests of verbal paired associates learning (89, 87) to confirm a hypothesis that interfering associations or response competition (34, 83) is more characteristic of the visual responses of dyslexic children than of normal controls.

b. The development of association tests in different modalities so that language responses are learned to i) visual ii) tactual, and iii) auditory patterns in an effort to determine whether deficits in acquisition of names constitute general failing or are modality specific. Is the disconnexion syndrome (Geschwind, 37) only visual-verbal?

c. In all association tests, variations need to be researched to determine the nature of the deficit i) does it take more association trials for the dyslexic to learn? ii) what is the effect of shortening or lengthening the list of associations at any one time on the dyslexic performance as compared with the normal control? iii) what is the relative effect of delayed recall on learned associations?

d. As an elaboration upon (a) analysis of types of responses (unusual vs. usual percentages) made by dyslexic vs. non-dyslexic children on classical word association tests (Kent and Rosanoff, 1910) as has been shown in some adult aphasics with alexia (2). This might support the hypothesis of unusual "richness' of visual-spatial association in dyslexic children, as proposed by Symmes and Rapaport (111).

4. Tests of word fluency:

In order to test word-finding fluency as distinct from visual-verbal (naming on confrontation) responses in dyslexic children, category-naming or word fluency (2) ought to be tested, again in comparison to non-dyslexic brain damaged and normal children. The child is asked to produce within three minutes all the names he can think of belonging to a specified category suchws "animals" or starting with the letter "p".

Such analysis of the psycholinguistic characteristics of dyslexic children should bring out the minimal brain difference in cognitive and learning styles which appear to correlate with slow acquisition of reading skills whether such differences are due to early brain damage, genetic patterns, environmental deprivation, or an unfortuitous combination of all of these is really inrrelevant. Except where medication is indicated for hyperkinetic behavior, solutions will have to be sought in compensatory education. This can only be achieved through painstaking research on patterns of differences between normal and abnormal development.

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